

Mission Design Considerations for Mars Cargo of the Human spaceflight Architecture Team's Evolvable Mars Campaign

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Recent NASA interest in human missions to Mars has led to an Evolvable Mars Campaign by the agency's Human Architecture Team. Delivering the crew return propulsion stages and Mars surface landers, SEP based systems are employed because of their high specific impulse characteristics enabling missions requiring less propellant although with longer transfer times. The Earth departure trajectories start from an SLS launch vehicle delivery orbit and are spiral shaped because of the low SEP thrust. Previous studies have led to interest in assessing the divide in trip time between the Earth departure and interplanetary legs of the mission for a representative SEP cargo vehicle.

Nomenclature

<i>ARV</i>	Asteroid Redirect Vehicle
<i>BOL</i>	Beginning Of Life (<i>electric power level</i>)
<i>COMPASS</i>	Collaborative Modeling for Parametric Assessment of Space Systems (<i>GRC study team</i>)
<i>EEO</i>	Elliptical Earth Orbit
<i>ELV</i>	Expendable Launch vehicle
<i>E – M</i>	Earth-to-Mars
<i>EMC</i>	Evolvable Mars Campaign
<i>GRC</i>	Glenn Research Center
<i>HAT</i>	Human Architecture Team
<i>LGA</i>	Lunar Gravity Assist
<i>MSFC</i>	Marshall Space Flight Center
<i>NASA</i>	National Aeronautics and Space Administration
<i>SEP</i>	Solar Electric Propulsion
<i>SLS</i>	Space Launch System
<i>STMD</i>	Space Technology Mission Directorate

I. Introduction

THE NASA Human spaceflight Architecture Team (HAT) has kicked off an Evolvable Mars Campaign (EMC). This campaign involves two main mission components: human transport and pre-deployed asset, or cargo, delivery. While the human transport missions have a strong focus on duration, the cargo delivery missions allow for longer trip times in order to reduce required propellant. Recent developments in Solar Electric Propulsion (SEP) have enabled efficient propellant use during orbital transfers and are considered a viable option for the EMC's asset delivery missions. The focus of this study is on such SEP asset delivery missions. Examples of assets to be pre-deployed in support of human missions are: landers and crew return stages.

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To date, several HAT studies have been performed and documented by a number of NASA teams including those at MSFC and GRC. The GRC studies have focused on cargo delivery using SEP. These missions typically consist of an Earth departure to escape segment and an in-space segment. The results have led to further interest in studying the divide in mission duration between these two segments. To that end, parameters such as mission segment duration, SEP power level, payload mass and Mars arrival conditions may be varied to examine the trade space for mission planning purposes. Trades of all these parameters will be the topic of a planned NASA publication. From this study, mission planning trends are shown as a result of time variation only.

II. Overview of HAT Cargo Mission

A. Mission Background and Spacecraft Description

In 2014, the NASA Human spaceflight Architecture Team started a study known as the Evolvable Mars Campaign to define how near term investments could build upon one another to enable human missions to Mars. Two alternate architectures, both involving the use of Solar Electric Propulsion, have been investigated in detail. The first, and the one focused on here, involves the use of a combination of SEP and chemical propulsion elements. This combination of propulsion technologies takes advantage of the strengths of each propulsion system: the high efficiency SEP system to deliver cargo, and the faster trip times afforded by chemical propulsion for crew transport. Referred to in past studies as a split architecture, the SEP system delivers the cargo using a vehicle separate from the crewed chemical transportation system. The SEP cargo vehicle delivers payloads, to be used on the surface of Mars, as well as the crew return propulsion stages. The second architecture, not discussed here, is referred to as a SEP/Chemical hybrid architecture and consists of a single crewed spacecraft which contains both SEP and chemical propulsion systems.

For the EMC architecture studied in this paper, the low-thrust SEP spacecraft is used to pre-position elements such as habitats, orbital maneuvering systems, consumables, and landers for use in the Martian system. As shown in Figure 1, the representative SEP stage was based on an evolved configuration of the Asteroid Redirect Vehicle (ARV): the approximately 150 kW class SEP Stage assumed the same spacecraft bus and the same high power hall thruster and solar array technologies as the current approximately 50 kW ARV. The dry mass assumptions for the SEP stage were based on scaling relationships with preliminary ARV designs. This scaling varied the total dry mass as a function of total power to the EP thruster system and total Xe propellant mass. This scaling relationship is shown in section B. Table 1 shows the main design parameters and constraints of the SEP vehicle used in this study. With an assumed augmented propellant capability, increased based on study results from the five metric tons in the current ARV, this SEP stage is launched on a single SLS vehicle to an elliptical starting orbit.

Item	Description
Engine technology	Magnetically Shielded Hall
Engine Isp	3,000 sec
Power to EP system	150 kW (degradation: $1/r^2$ for $r > 1$ AU where $r = \text{spacecraft radius to Earth}$)
Thruster efficiency ^a	60%
Thruster duty cycle	90%
Propellant	Xe (amount derived from analysis)
Solar array technology	ROSA (shown)
Number of wings	2
Wing diameter	18.7 m
Power per wing	75 kW

^a Reference value from ARV; HAT study value based on specific thruster model (see section B)

Table 1: 150 kW SEP Stage Design Parameters and Constraints

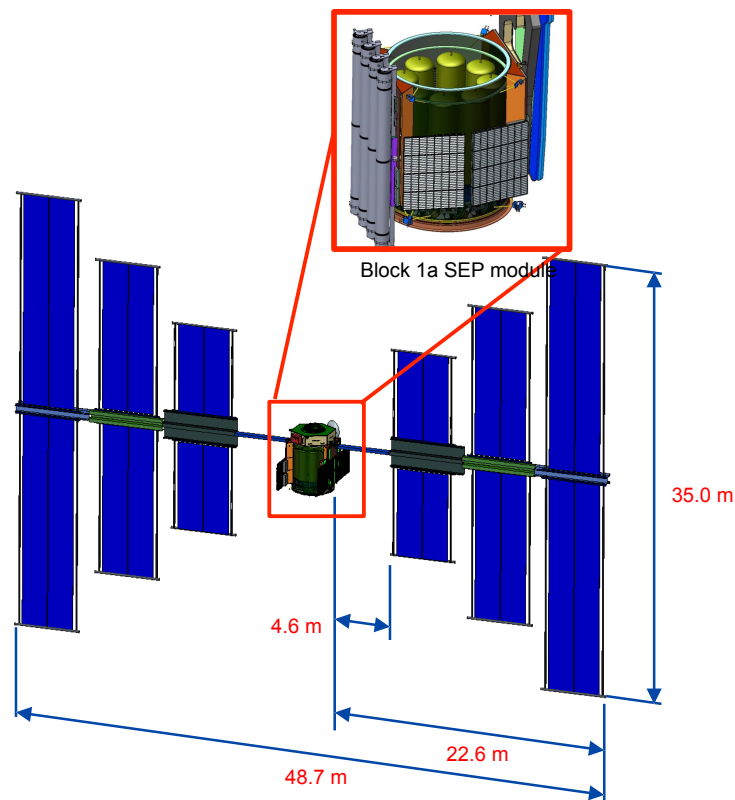


Figure 1: Representative HAT Spacecraft Design

B. Mission Description

In this study, the HAT cargo mission starts with an assumed SLS, or other ELV, launch delivery into Elliptical Earth Orbit (EEO). This orbit is always assumed to have a perigee altitude of 200 km while the apogee altitude may vary based on launch vehicle capability. From the EEO, the SEP powered spacecraft

performs a low thrust spiral transfer to a near Earth escape condition defined as having a characteristic energy (or C_3) equal to $-2.0 \text{ km}^2/\text{sec}^2$. From this condition there is an assumed Lunar Gravity Assist (LGA) that provides a free transfer to an Earth escape condition defined as having a characteristic energy (or C_3) equal to $+2.0 \text{ km}^2/\text{sec}^2$. Finally, from the Earth escape condition, the SEP system performs an interplanetary transfer to the desired Mars arrival condition defined as having an incoming excess velocity (or V_{inf}) equal to 5.2 km/sec . This Mars arrival condition has been derived as a requirement for a subsequent aero-capture maneuver, not modeled in this study, that allows for the planetary capture into Mars' sphere of influence. Table 2 shows an overview of the Ground Rules and Assumptions (GRA) for the cargo mission.

Item	Description
Spacecraft power (kW)	BOL: 150 Earth spiral degradation: <i>10% linearly as a function of perigee alt (H_p); from $H_p = 1,200$ to $24,000 \text{ km}$</i> Earth-Mars degradation: $1/r^2$ where $r = \text{spacecraft radius to Earth}$ SEP system is off in shadow (for Earth spiral)
Spacecraft propulsion	Thrust and Mass flow per GRC developed "STMD rev 2.2" curves for High I_{sp} ^{1,2} ; Duty cycle = 90% (used for Earth departure spiral only) Averaged values (used for Earth-Mars transfer only): $I_{sp} = 3215.5360$, Overall efficiency (thruster eff*duty cycle): 0.522139
Spacecraft Dry Mass (kg)	Scaling eq format: fixed component + power plant sizing + tank sizing Scaling eq ^a : $2274.61 \text{ [kg]} + 30.1925 \text{ [kg/kW]} * \text{power [kW]} + 0.0552 \text{ [n/d]} * \text{prop mass [kg]}$
Payload System	50,000 kg
Mission	
Starting date	Derived through optimization
Starting orbit at Earth	$200 \times H_a \text{ km}$, where $H_a = \text{apogee altitude derived through optimization}$
Earth escape condition	$C_3 = +2.0 \text{ km}^2/\text{sec}^2$
Mars arrival condition	$V_{inf} = 5.2 \text{ km/sec}$

^a Mass scaling equation derived from spacecraft designs in previous NASA GRC COMPASS studies

Table 2: Ground Rules and Assumptions for the Cargo Mission

III. Analysis Strategy and Tools

As outlined above, there are three main components in the mission profile: Earth departure, LGA and interplanetary transfer. Each of these components is discussed below along with the corresponding analytical tools used. The overall goal of this study is to assess a fairly wide range of possible missions to enable proper mission planning. As such, appropriate analytical tools are used and assumptions made. It is considered that an overall medium level of analytical fidelity is appropriate for this study because only approximate and relative performance metrics are of interest. Once a down selection of feasible missions has been made, further refinement in the fidelity of mission models can be made to ascertain mission performance measures with greater accuracy, as needed.

A. Earth Departure Spiral

The Earth departure segment of the mission starts from an assumed SLS, or other ELV, delivery orbit around the Earth. This orbit always has a perigee altitude of 200 km and an inclination of 28.5 degrees. Because of the low thrust nature of the SEP system of the spacecraft, the orbit transfer to near Earth escape condition of $C_3 = -2.0 \text{ km}^2/\text{sec}^2$ takes on the shape of a spiral. This occurs because the SEP provided ac-

celeration is on the order of magnitude of the Earth's gravitational acceleration which causes the spacecraft to continue to orbit the Earth during the relatively long duration transfer, hence the spiral shape.

Spiral shaped orbits present unique challenges for proper analytical modeling because of their long duration; typically on the order of days, months or even years. This segment of the mission is modeled to a high level of analytical accuracy using version 4 of the Optimal Trajectories by Implicit Simulation (OTIS)³ program. This version of OTIS employs a closed loop guidance algorithm that provides near optimal steering to achieve the desired orbital targets at the end of the orbital transfer. The OTIS simulation model accounts for, among others, gravitational effects due to the Earth and it's moon, the Sun and Jupiter. Shadowing effects on the vehicle are accounted for by turning off the thrusters while in shadow. A simplified solar array degradation model, to account for Van Allen belt radiation, is implemented by degrading the electric power to the thrusters as a linear function of the perigee altitude. This model reduces the power by a total of 10% starting at a perigee altitude of 1,200 km at BOL power and ending at a perigee altitude of 24,000 km at 90% of BOL power. This segment of the mission is modeled with the highest level of fidelity of all segments in this study and, consequently, is also the most expensive in terms of computer CPU time. Figure 2 shows a representative Earth departure spiral trajectory created with OTIS.

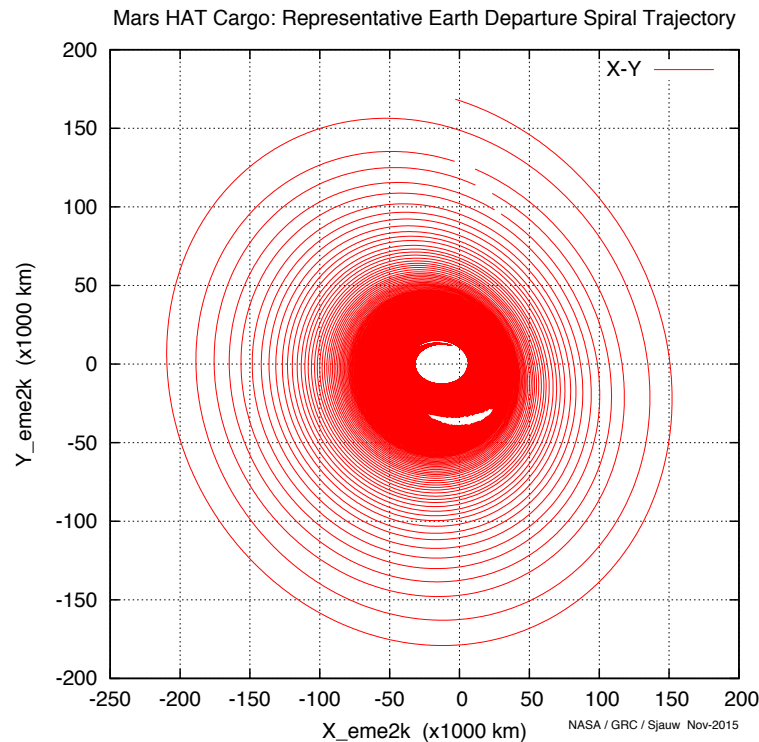


Figure 2: *Representative Earth Departure Spiral (to $C_3 = -2.0 \text{ km}^2/\text{sec}^2$) - Cutouts indicate s/c in shadow*

To alleviate the CPU time cost, a database of Earth departure spirals has been created which is then interrogated for Earth spiral trajectories of interest. Several parameters are varied to generate the database and, as a result, it is actually a data surface for interpolation purposes. The assumption is that the Earth spiral performance is repetitive in nature from year to year; the year 2033 was chosen. To capture variations within the year, the stating date was varied on a quarterly basis; specifically, a date around the midpoint of each quarter was chosen as the reference date. Starting mass is derived from using a recent SLS ASB

performance table⁴ which provides SLS delivery performance as a function of apogee altitude of an Earth orbit with a 200 km perigee altitude and an inclination of 28.5 deg. To somewhat decouple the database from the SLS performance table, "bands" were placed around the reference performance for each selected starting orbit. This allows a reference orbit to have a range of possible launch vehicle performance values. The "bands" were chosen so that there was no overlapping performance between selected starting orbits in order to preserve the original orbit performance variation; i.e. a specific initial EEO can never have a higher delivered mass than a lower EEO from the reference SLS performance table. Earth spiral trajectories with a planar transfer were then generated per table 3. After the initial data surface was generated, it was resorted based on the final mass and quarter of the year. The intended use of the data surface is based on a specified final (near Earth escape) mass and reference quarter of the year. Multidimensional interpolation is performed to provide Earth spiral performance numbers based on final mass, desired BOL power level and quarter of the year. Table 4 lists the performance parameters that are available from the data surface. It should be noted that, even though a particular quarter of the year is determined for interpolation purposes, it serves merely as a guide to down select a subset from the data surface. Actual interpolation of the dates in the database are not of interest; however, the useful and desired output time parameter is the trip time of the Earth departure spiral trajectory. This duration is combined with the date near Earth escape (described below) to derive the starting date in the EEO. At no point is the data surface extrapolated since those results could be unpredictable. If the requested final mass is below the delivered SLS capability, this delivered capability is used and an excess capability from the Earth spiral is reported. If, however, the requested final mass exceeds that of the Earth spiral capability then no feasible Earth spiral is available and that condition is reported; no "end-to-end" scenario is possible in this case. The Earth spiral represents the first leg of the overall mission.

Input Parameter	Value
Date	Year: 2033 (<i>reference year, performance assumed repeating each year of interest</i>) Quarterly variation: q1, q2, q3, q4
BOL Power Level (kW)	Discrete reference values: 150, 250, 300
Initial Mass (kg)	Approx. range: 56k to 113k

Table 3: *Input Parameters to generate the Earth Spiral Data Surface*

Output Parameter	Value
Date (yyyy/mm/dd)	Initial, Final
Mass (kg)	Initial, Final, Propellant used
Other	Trip time (days), Delta V (km/sec)

Table 4: *Output Parameters from the Earth Spiral Data Surface and, also, from the Comprehensive Search Program*

B. Near Earth Escape and LGA

Following the near Earth escape condition at the end of the Earth spiral, defined as having a $C_3 = -2.0 \text{ km}^2/\text{sec}^2$, there is an assumed Lunar Gravity Assist (LGA) to provide the transfer to an Earth escape condition defined as having a $C_3 = +2.0 \text{ km}^2/\text{sec}^2$. The LGA itself is not modeled in this study; the assumption is that the LGA is achieved via proper mission planning without propulsive contribution from the spacecraft.⁵ This is a reasonable assumption for the purpose of this study and allows for modeling the two adjacent mission segments with separate tools while connecting them in a comprehensive optimization framework to provide end-to-end results that are reconciled; i.e. vehicle "closure" based on consistent mass and tank sizing is thus achieved. Once a down selection of feasible missions has been made, subsequent higher fidelity mission analysis is expected to actually model the LGA. To account for the LGA in the mission timeline,

a shift of 60 days is implemented between the end of the Earth spiral and the start of the Earth-to-Mars transfer segment. Per current HAT analysis agreement, a time span of 60 days is sufficient to allow for proper alignment for achieving an LGA; it also allows for additional time margin for potentially unforeseen scenarios such as missed thrust.

C. Earth to Mars Transfer

The Earth-to-Mars (E-M) transfer starts at an Earth escape condition defined as having a $C_3 = +2.0 \text{ km}^2/\text{sec}^2$ and ends at Mars with an incoming $V_{inf} = 5.2 \text{ km/sec}$. The Mars arrival condition is driven by aero-capture requirements at Mars. This mission segment is modeled using the Chebytop III⁶ program. Chebytop is chosen because of its flexibility and speed in providing optimized interplanetary trajectories. Chebytop has a medium level of simulation fidelity, as defined by specified vehicle and mission detail, and is suitable for the study at hand. Prior experience has shown that Chebytop solutions provide excellent seed values for higher level fidelity trajectory programs. Where higher level fidelity trajectory programs allow for more vehicle detail and mission constraints to be specified, they typically get "trapped" in local solution spaces; unlike Chebytop, they are simply not the tools for examining a wide range of the solution space. Their purpose is to provide added modeling detail to a specific mission of interest. Also, when examining a wide solution space of interest, the focus is on solutions that are feasible and, performance-wise, a comparative approach is needed; i.e. some vehicle and mission modeling details are sacrificed in favor of comparing multiple solutions from a somewhat simpler, common basis. Finally, Chebytop has two modes of solution: variable thrust mode and constrained thrust (i.e. fixed Isp) mode. For this study, the constrained thrust mode was used. Figure 3 shows a representative Earth-Mars transfer trajectory created with Chebytop III.

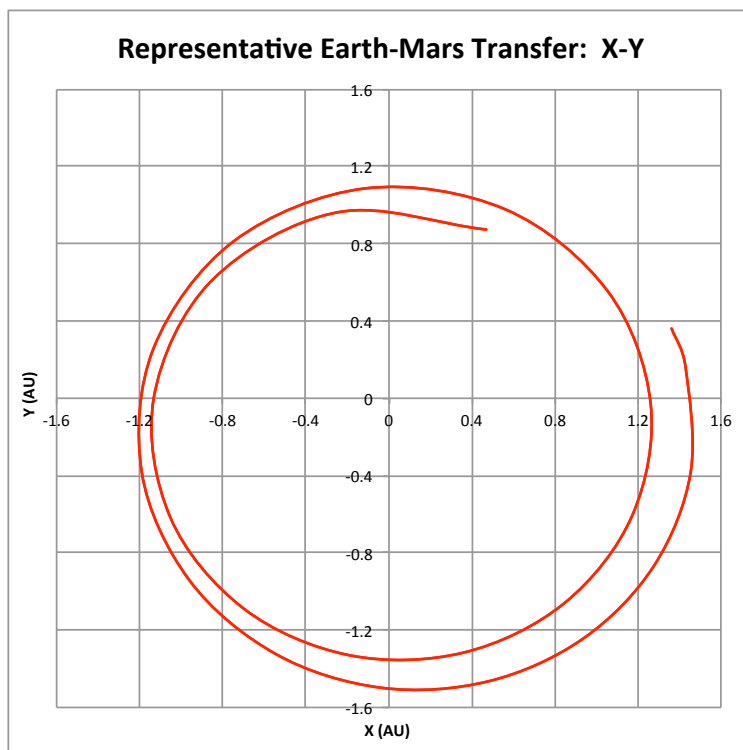


Figure 3: *Representative Earth-Mars Transfer (to $V_{inf} = 5.2 \text{ km/sec}$ - 2036_11_24 case for E-M trip= 975 days)*

Because of Chebytop's ability to derive good near optimal solutions in rapid fashion, it lends itself for incorporation into a comprehensive search and optimization framework. For the purposes of this study such a framework was specifically created. This newly developed software is described in the next section.

D. Putting the pieces together

In order to arrive at end-to-end mission solutions for each data point in a wide solution space, a new software program was developed to manage the comprehensive search and optimization. Several layers of searching are performed over a wide range of dates. The top level trade is between the time span of the two main mission segments: Earth departure spiral (to near escape) and E-M transfer. The software allows for additional parameters that may be traded such as power level and final payload mass; these parameter trades vastly expand the solution set and are the subject of another planned NASA publication. For the purposes of this study, the BOL power level and required payload are each fixed to a single value in order to keep the number of results manageable.

The new software may be viewed as an executive program that manages the generation of valid solutions for dates of interest. The program may be run in two modes: end-to-end solution generation and interplanetary-only solution generation. For this study, both modes were used. Table 5 shows the input parameters for the comprehensive search process while Table 4 shows the output parameters.

Input Parameter	Description
y0, y1	start, end year (yyyy) at Earth escape (<i>i.e. starting year of E-M segment for the outermost search loop</i>)
em_trip0, em_trip1, em_trip_dt	start, end, step trip time (days) for the E-M segment (<i>i.e. duration of the E-M segment; used in an inner search loop in conjunction with each year in the outermost loop</i>)
refpwr	BOL power level (kW)
payload	payload mass (kg) at the end of the mission (<i>i.e. at Mars</i>)
sc_dry_in	spacecraft dry mass (kg): non-negative = fixed mass; negative = use mass scaling equation
cheby_only	false= end-to-end mission (<i>i.e. include Esprl</i>); true= E-M only
Other	
Filenames	input, output file names
Iteration, tolerance	iteration count, tolerance settings for search, optimization procedures

Table 5: *Input Parameters for the Comprehensive Search Program*

The program is built with a multi-layer search in mind. Figure 4 shows a top level diagram of the search process. The outermost layer sweeps through the years of interest; these apply at Earth escape. For each selected year, the next layer sets the E-M trip time of interest and, for each specified length, produces valid near optimal performance solutions based on an Earth escape date search for that year. A valid solution is one where the required power level to accomplish the mission does not exceed the available power level of the spacecraft. Using the the Earth escape date previously found, the next layer performs an iterative search for near optimal solutions that satisfy the payload target. For end-to-end mode, the Earth spiral data base is interrogated to select a matching Earth spiral. It should be noted that the Earth escape date is adjusted backwards by 60 days to account for the LGA and margin; this derived date is considered the "end" date of the Earth departure spiral to near escape. Therefore, once an Earth spiral is selected, the starting date of the mission, in Earth orbit, is known by adjusting backwards in time using the spiral duration. For cases where a spacecraft mass scaling equation is used (*i.e. for this study*), the propellant from the Earth spiral and that from the E-M transfer are used to compute the spacecraft dry mass such that the spacecraft tanks can contain the required amount of propellant. This newly computed mass, along with the payload mass, is used in another iterative loop to "close" the spacecraft mass. Closure of the spacecraft mass means that the optimized final mission mass delivered to Mars arrival condition accounts for the sum of the payload mass and the spacecraft dry mass. The whole process repeats for each specified E-M trip time. As the E-M trip time is varied, the Earth spiral time adjusts accordingly to match up the segments of the mission

thereby providing the mechanism to trade the time divide between the mission segments. E-M trip time subsequently increases according to a user specified step size in the E-M trip time loop. Once the maximum E-M trip time is reached, the process then repeats for the next year in the outermost search loop; this whole process continues until the last specified year is reached.

For E-M transfer only (i.e. no end-to-end mission requested), the above process is the same except that the Earth spiral segment is not generated. The intent of this mode of analysis is to allow for additional mission planning where the spacecraft is delivered to the Earth escape condition via an assumed non-spiral out method; e.g. a chemical stage providing a high thrust impulse to place the spacecraft at the desired pre-LGA, or even at the desired Earth escape, condition. For those types of missions, the E-M transfer segment can be used to complete such alternate scenarios.

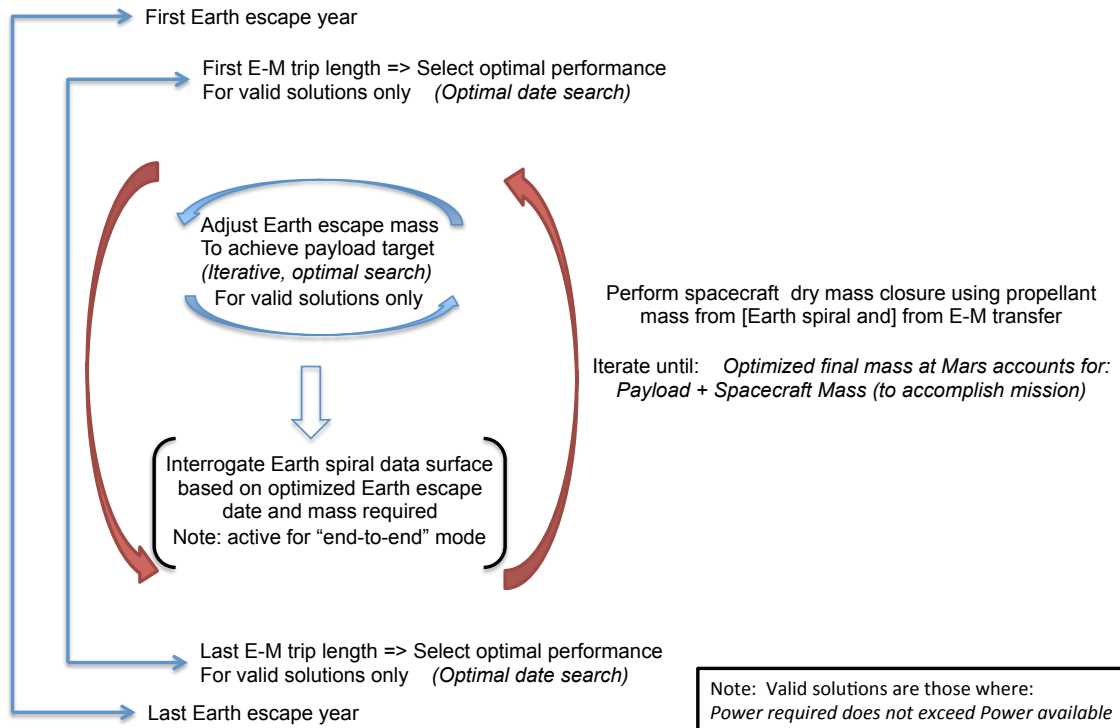


Figure 4: *Solution process for Comprehensive Search*

IV. Results

This study was first conducted for the end-to-end option of the HAT Cargo mission. The analysis was then repeated for the E-M segment only. Table 6 shows the analysis ranges in this study.

Parameter	Values
Year at Earth escape	2028 - 2048; 1 year increment
E-M trip time	600 - 1200 days; 37.5 day increment
BOL power level	150 kW
Payload (kg)	50,000 kg
Spacecraft dry mass (kg)	computed via Table 2 mass scaling equation

Table 6: *Analysis Ranges*

A. EEO to Mars Arrival

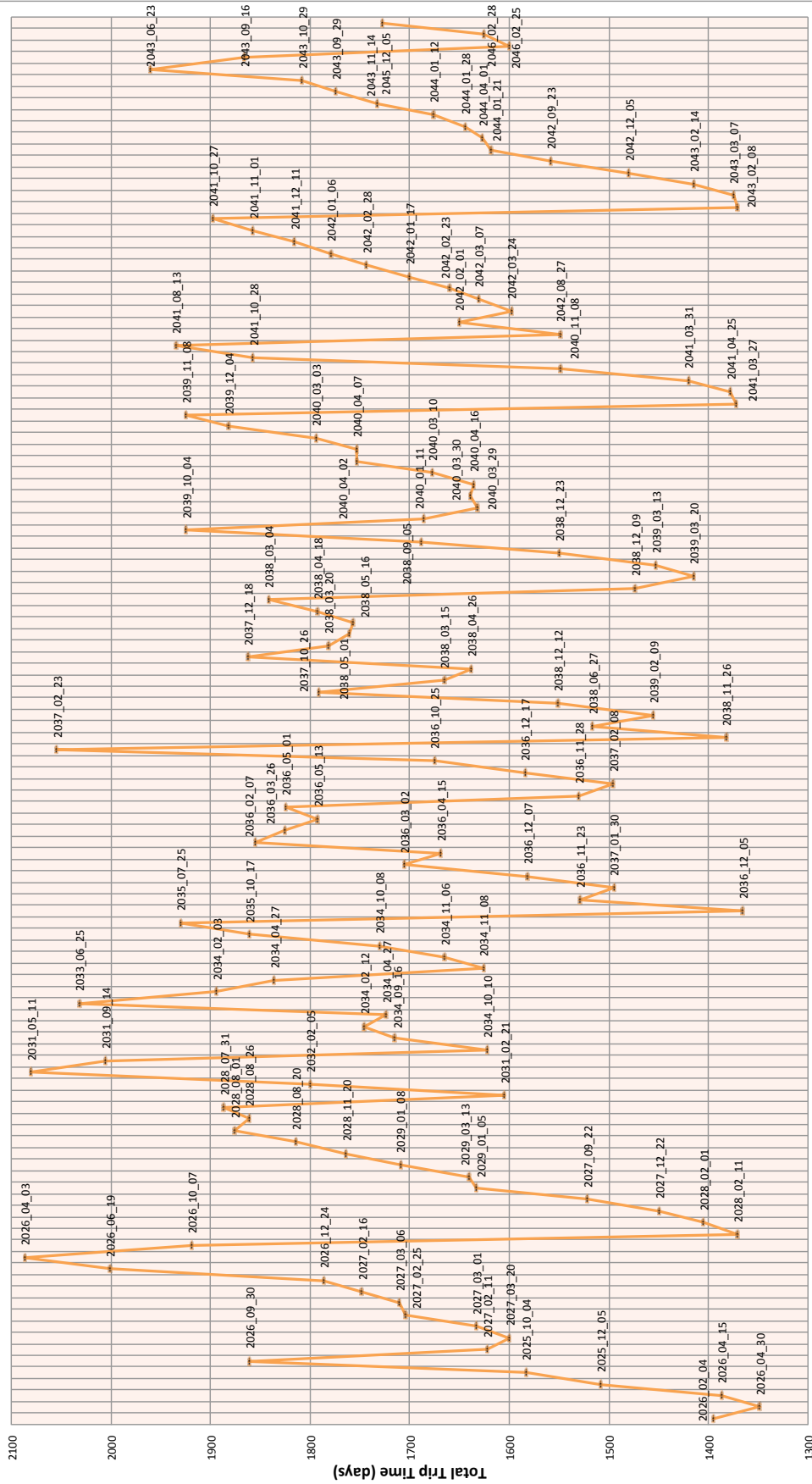
Figure 6 shows the total trip time for departure from EEO to Mars arrival; this plot shows the complete time span for Earth departures from 2026 to 2046; for purposes of this study, these are referred to as "launch date". It should be noted that the corresponding Earth escape dates range from 2028 to 2048 indicating Earth spiral out durations of up to 2+ years in some cases. For legibility purposes the time span is divided into two and plotted in the next two figures. Figure 7 shows the total trip time and the total mission deltaV for a launch date range from 2026 to 2037 while Figure 8 shows the same for a launch date range from 2037 to 2046. While Earth escape dates are sequential, launch dates are not because of the varying Earth spiral durations. Because of this non-sequential nature of the launch dates, for the boundary date of 2037, both figures 6 and 7 should be consulted. Figure 5 shows sample summary output for two of the data points in the plots: the output parameters indicated in Table 4 are shown along with mission totals. Appendix A shows the complete set of results; i.e. a summary for each data point. The intent is to use the plots to determine missions of interest based on launch date, mission duration and deltaV cost. Then specific missions of interest can be examined using the summary results. As mission planning efforts mature, the selected missions can subsequently be analyzed in greater detail.

Finally, figures 9 and 10 show the data for the Earth spiral portion of the end-to-end scenarios. While these results are not independent from corresponding end-to-end scenarios, examining them separately can help in launch vehicle planning and delivery options to Earth escape.

Esprl:	pwr: 150.0	m0:	68335.1	Start	2034_04_27	End	2036_01_24	mf:	60833.2	trip:	636.1	mp:	7501.9	dv:	3.6668
E-M:	pwr: 135.0	m0:	60833.2	Earth	2036_03_24	Mars	2039_07_07	mf:	57403.1	trip:	1200.0	mp:	3430.0	dv:	1.8301
		E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7403.1	p/l:	50000.0	Ttrip:	1836.1	Tmp:	10932.0	Tdv:	5.4969
Esprl:	pwr: 150.0	m0:	71257.3	Start	2034_11_08	End	2036_11_03	mf:	62597.3	trip:	726.1	mp:	8660.1	dv:	4.0511
E-M:	pwr: 135.0	m0:	62597.3	Earth	2037_01_02	Mars	2039_06_21	mf:	57555.6	trip:	900.0	mp:	5041.6	dv:	2.6479
		E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7555.6	p/l:	50000.0	Ttrip:	1626.1	Tmp:	13701.7	Tdv:	6.6990

Figure 5: *Sample Summary Output from Results Data Set of End-to-End Missions*

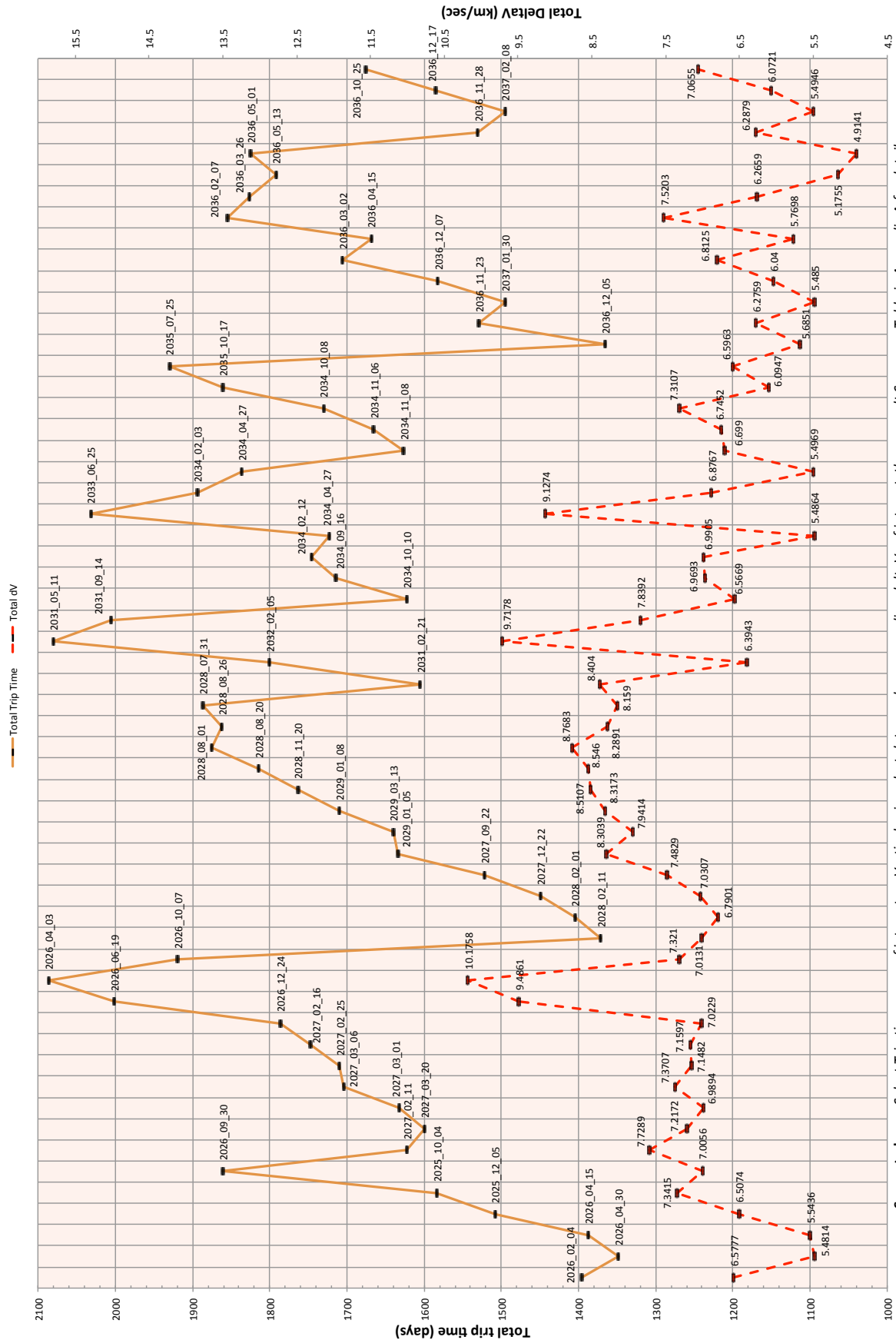
HAT Cargo Mission: Total Trip Time vs Launch Date - 2026 to 2046 Range
BOL pwr= 150 kW; 10% Esprl degradation; E-M 1/r2 degradation; Mars Vinf= 5.2 km/sec; Payload= 50 mT



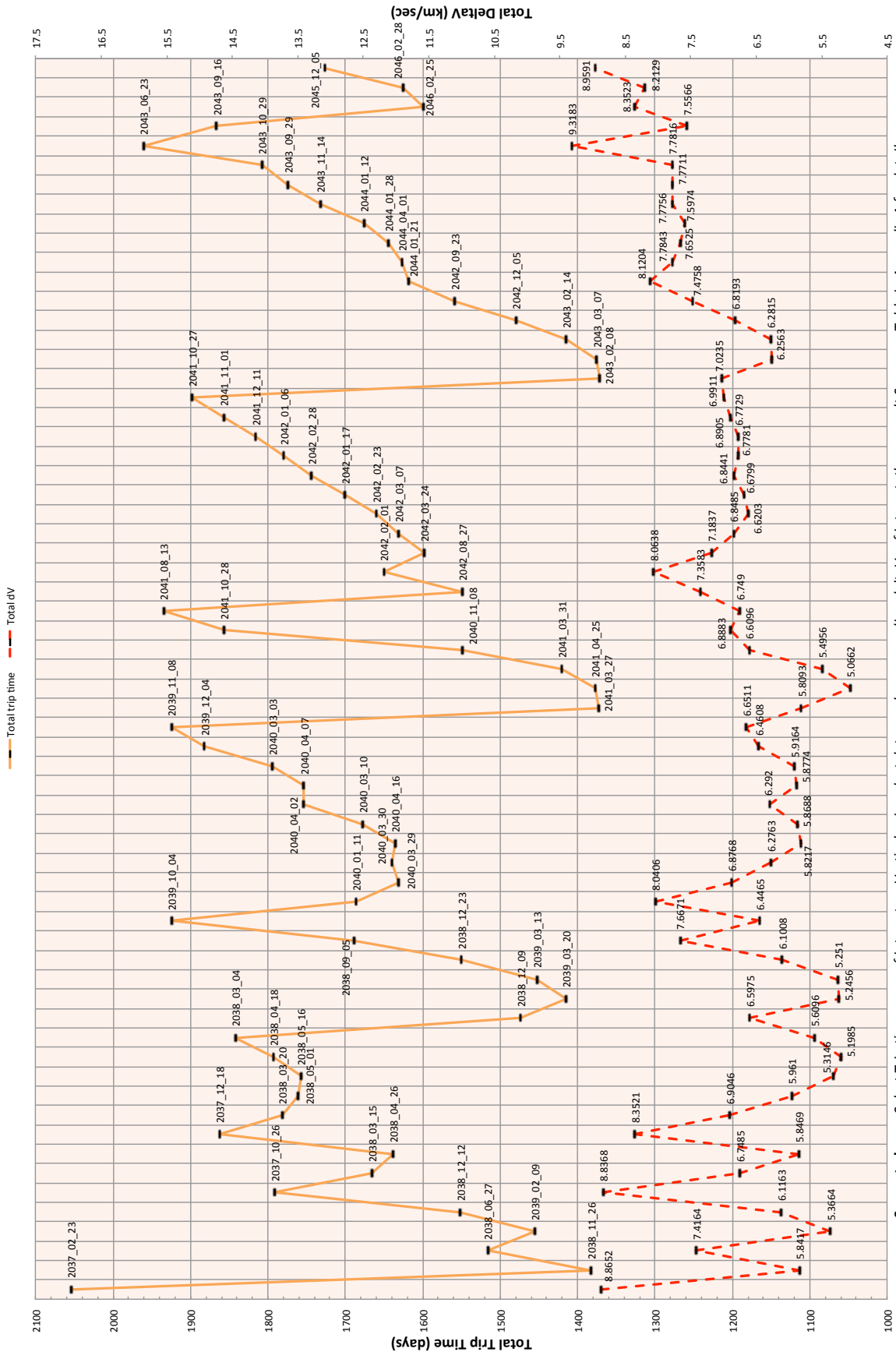
Suggested use: Select Trip time range of interest on Vertical axis, select dates of interest, then consult Summary Table in Appendix A for details

Figure 6: EEO to Mars - Complete Launch Time Span: 2026 to 2046

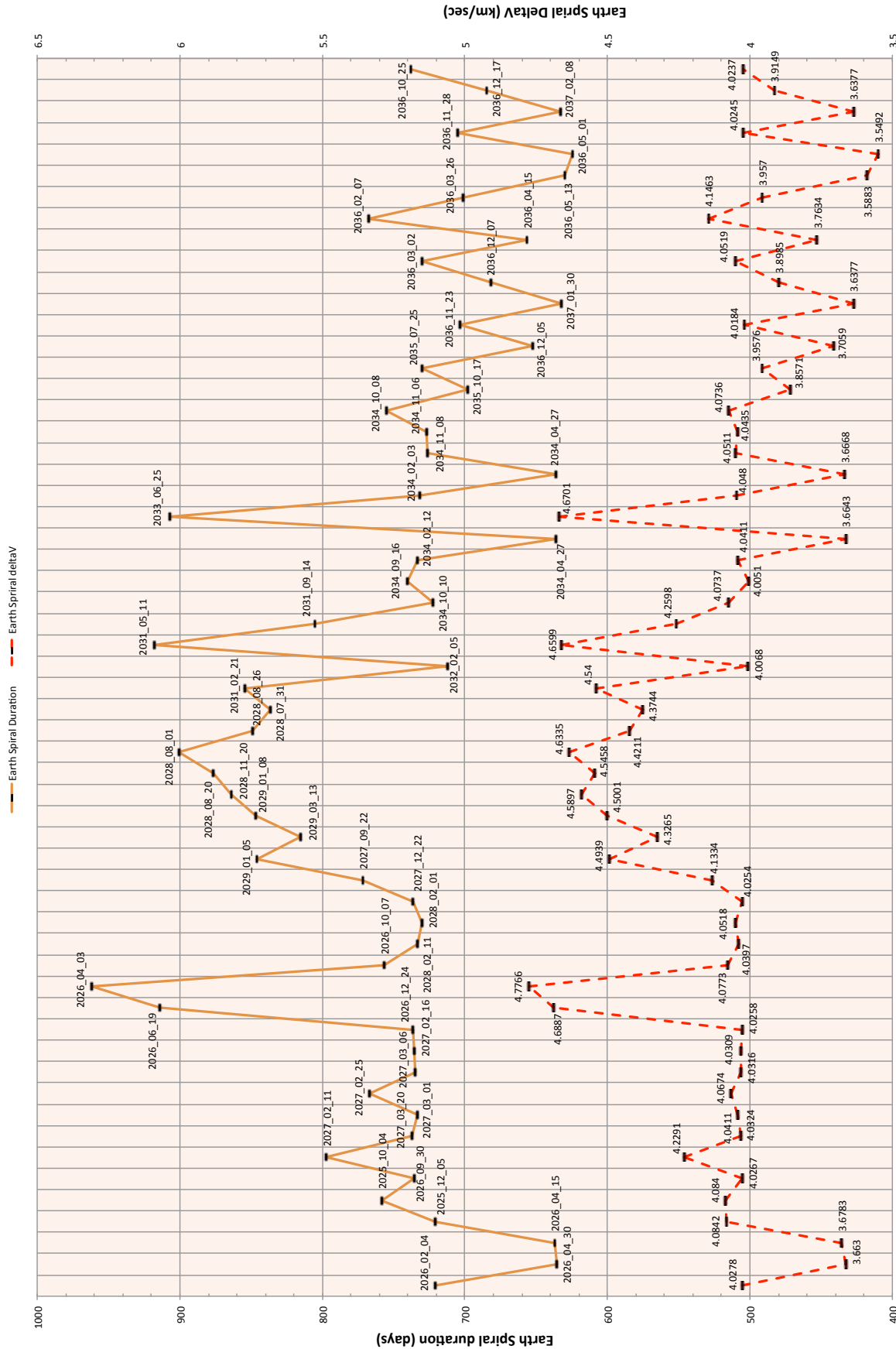
HAT Cargo Mission: Total Trip Time, DeltaV vs Launch Date - 2026 to 2037 Range
 BOL pwr= 150 kW; 10% Esprl degradation; E-M 1/r2 degradation; Mars Vinf= 5.2 km/sec; Payload= 50 mT



HAT Cargo Mission: Total Trip Time, DeltaV vs Launch Date - 2037 to 2046 Range
 BOL pwr= 150 kW; 10% Esprl degradation; E-M 1/r2 degradation; Mars Vinf= 5.2 km/sec; Payload= 50 mT



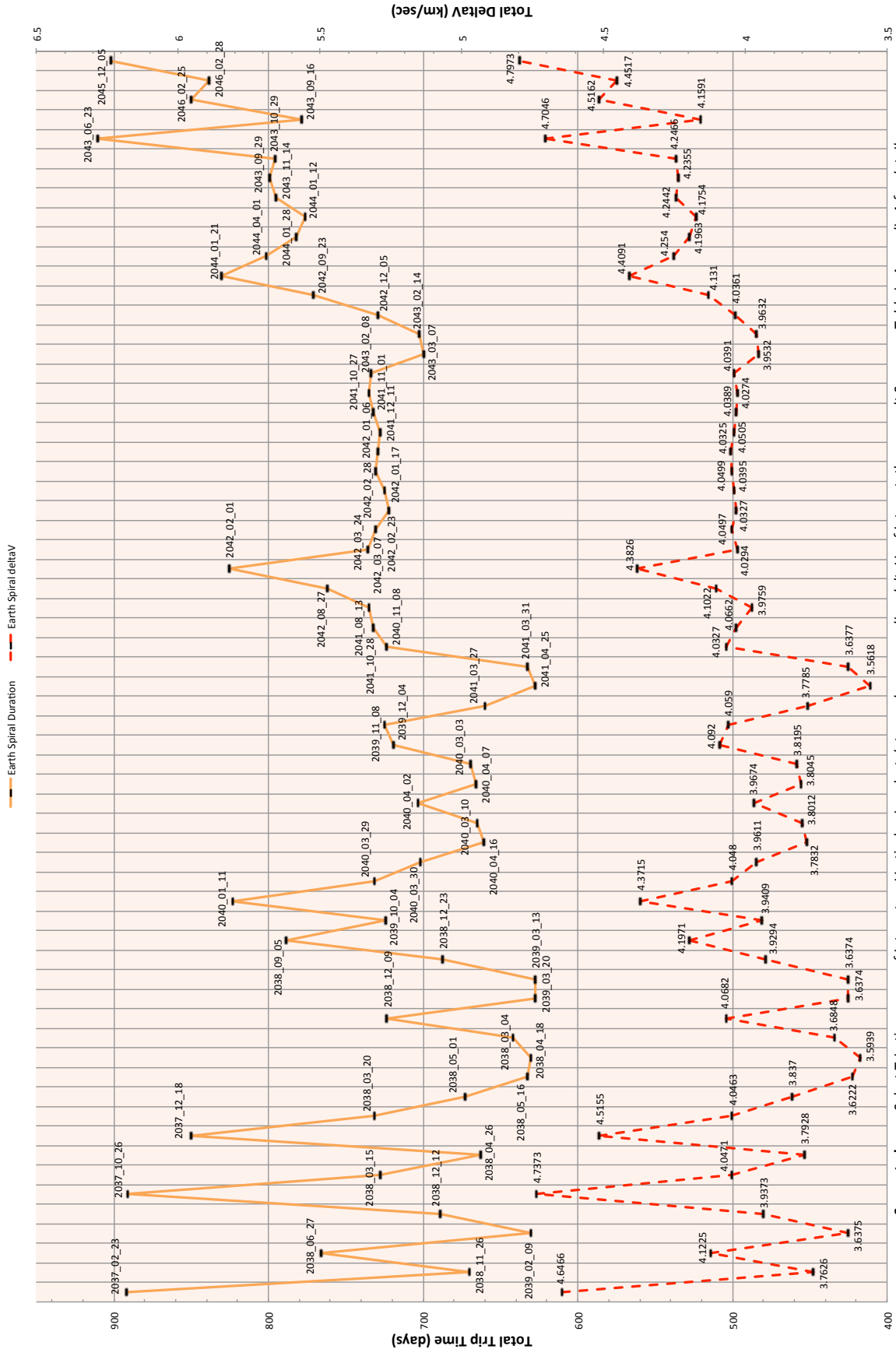
HAT Cargo Mission: Earth Spiral Duration, DeltaV vs Launch Date - 2026 to 2037 Range
BOL pwr= 150 kW; 10% Espri degradation; Ending $C_3 = -2.0 \text{ km}^2/\text{sec}^2$ *Spiral data taken from corresponding end-to-end scenario*



Suggested use: Select Trip time range of interest on Vertical axis, select dates and corresponding deltaVs of interest, then consult Summary Table in Appendix A for details

Figure 9: Earth Spiral - Launch Time Span: 2026 to 2037

HAT Cargo Mission: Total Trip Time, DeltaV vs Launch Date - 2037 to 2046 Range
BOL pwr= 150 kW; 10% Esprl degradation; Ending $C_3 = -2.0 \text{ km}^2/\text{sec}^2$ *Spiral data taken from corresponding end-to-end scenario*



Suggested use: Select Trip time range of interest on Vertical axis, select dates and corresponding deltaVs of interest, then consult Summary Table in Appendix A for details

Figure 10: Earth Spiral - Launch Time Span: 2037 to 2046

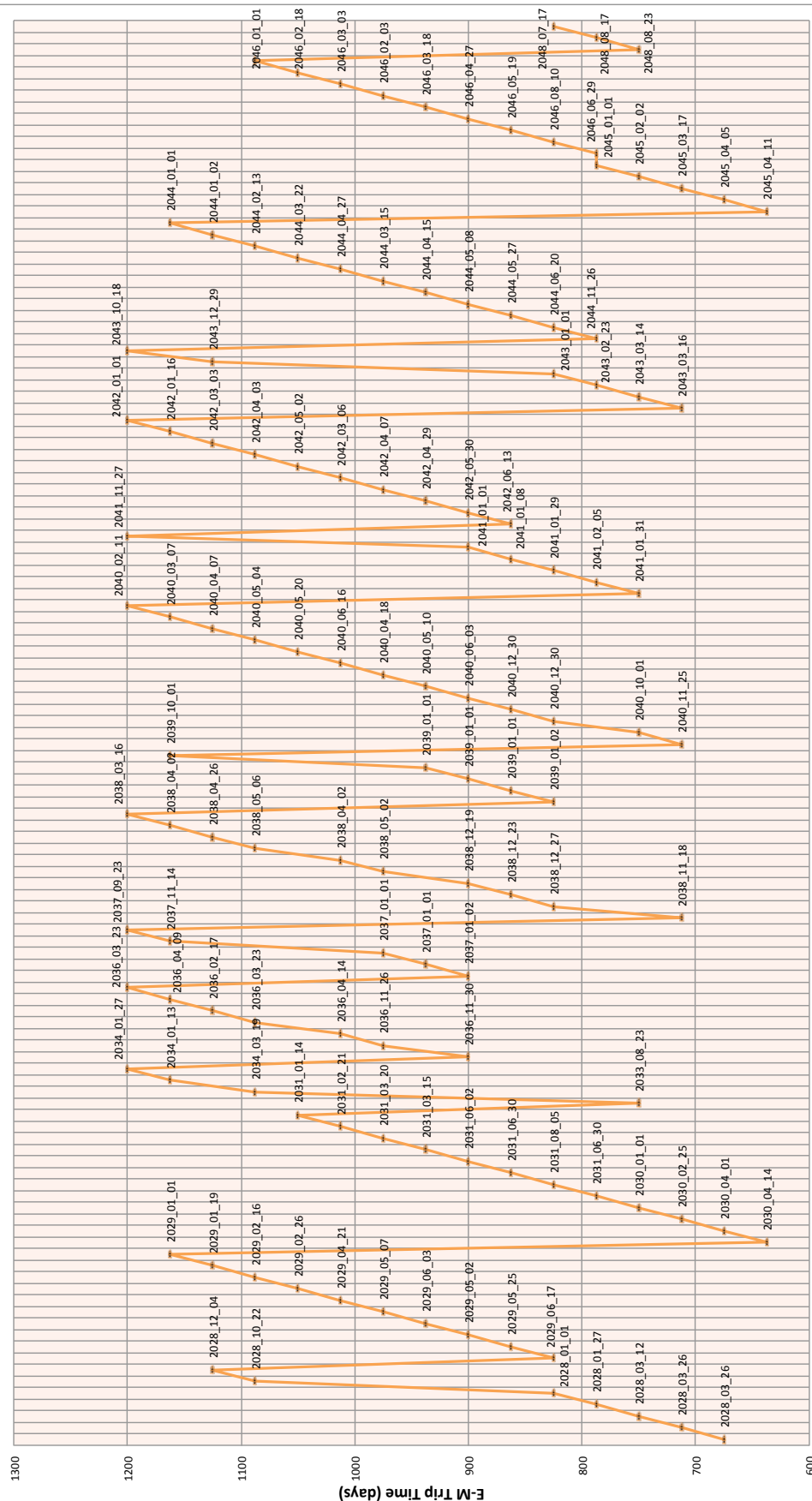
B. Earth Escape to Mars Arrival (*interplanetary only*)

The analysis was repeated for only the Earth escape to Mars segment by skipping the Earth departure spiral trajectory. This interplanetary-only mission segment may be used by itself or in combination with other mission segments to arrive at end-to-end performance estimates. Figure 11 shows a snippet of the performance summary table. Figures 12, 13 and 14 show the total trip time versus launch date for the total time span and, again, split into two segments. The last two figures also show the total deltaV.

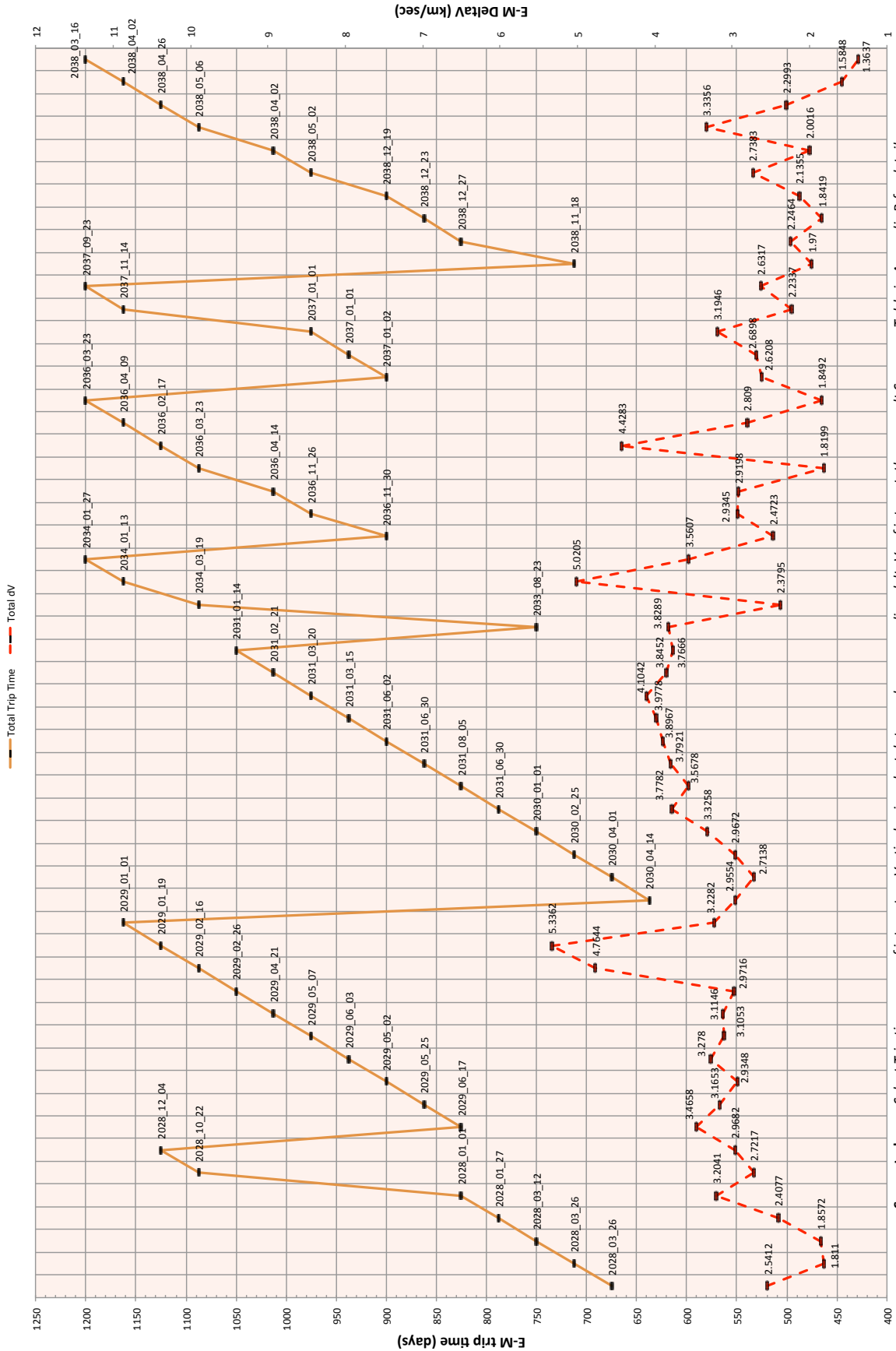
E-M:	pwr: 135.0	m0: 63812.0 E_Vinf: 1.4142	Earth 2029_06_17 M_Vinf: 5.2000	Mars 2031_09_20 s/c: 7170.1	mf: 57170.1 p/1: 50000.0	trip: 825.0 Ttrip: 825.0	mp: 6641.8 Tmp: 6641.8	dv: 3.4658 Tdv: 3.4658
E-M:	pwr: 135.0	m0: 63169.6 E_Vinf: 1.4142	Earth 2029_05_25 M_Vinf: 5.2000	Mars 2031_10_04 s/c: 7136.5	mf: 57136.5 p/1: 50000.0	trip: 862.5 Ttrip: 862.5	mp: 6033.1 Tmp: 6033.1	dv: 3.1653 Tdv: 3.1653
E-M:	pwr: 135.0	m0: 62681.5 E_Vinf: 1.4142	Earth 2029_05_02 M_Vinf: 5.2000	Mars 2031_10_19 s/c: 7111.0	mf: 57111.0 p/1: 50000.0	trip: 900.0 Ttrip: 900.0	mp: 5570.5 Tmp: 5570.5	dv: 2.9348 Tdv: 2.9348

Figure 11: *Sample Summary Output from Results Data Set of E-M Missions*

HAT Cargo Mission: Earth-Mars Trip Time vs Earth Escape Date - 2028 to 2048 Range
BOL pwr= 135 kW; E-M 1/r² degradation; Mars Vinf= 5.2 km/sec; Payload= 50 mT



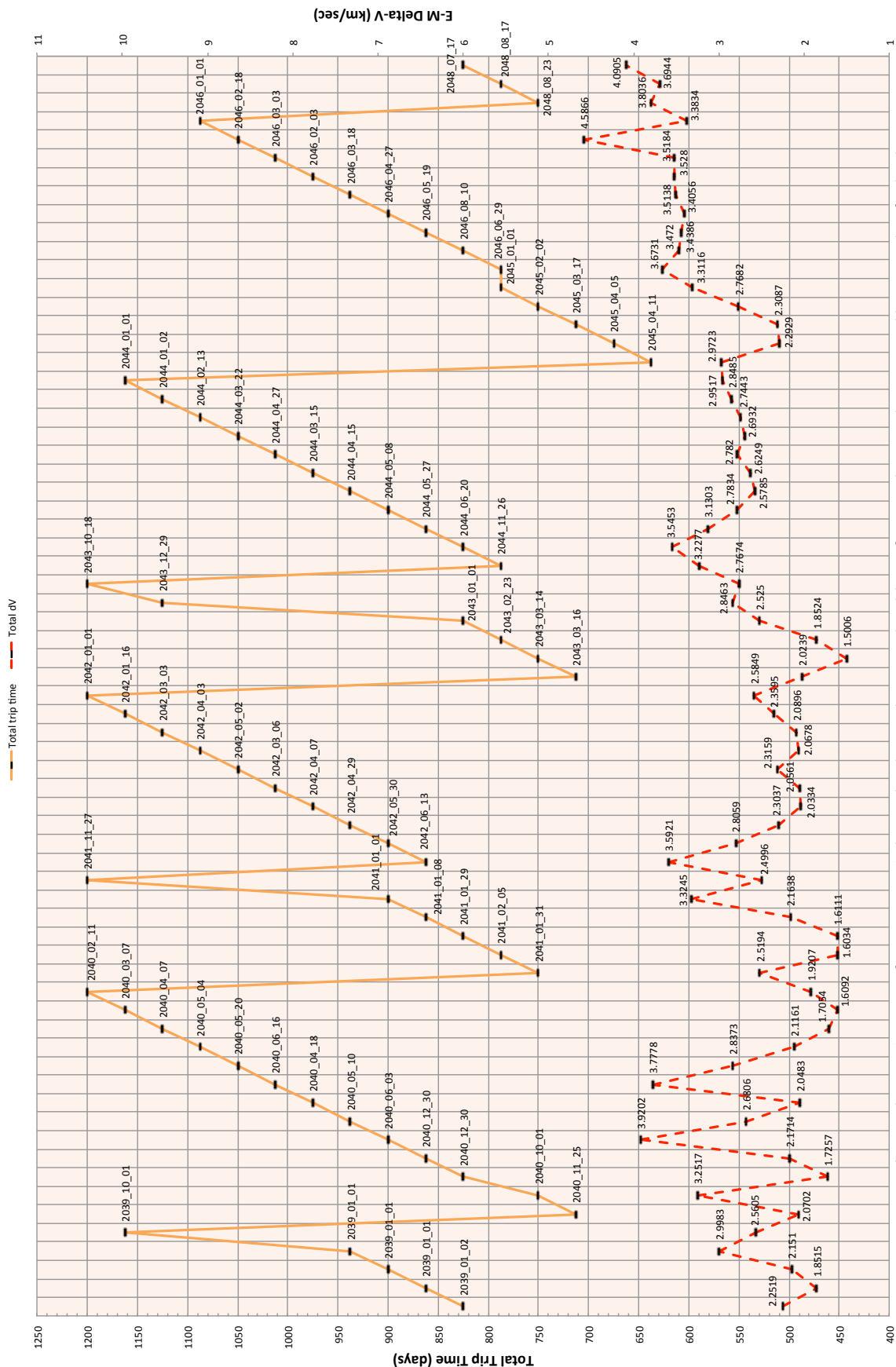
HAT Cargo Mission: Earth-Mars Trip Time, DeltaV vs Earth Escape Date - 2028 to 2038 Range
BOL pwr= 135 kW; E-M 1/r2 degradation; Mars Vinf= 5.2 km/sec; Payload= 50 mT



Suggested use: Select Trip time range of interest on Vertical axis, select dates and corresponding deltaVs of interest, then consult Summary Table in Appendix B for details

Figure 13: Earth Escape to Mars - Launch Time Span: 2028 to 2038

HAT Cargo Mission: : Earth-Mars Trip Time, DeltaV vs Earth Escape Date - 2039 to 2048 Range BOL pwr= 135 kW; E-M 1/r² degradation; Mars Vinf= 5.2 km/sec; Payload= 50 mT



V. Summary and Conclusions

An integrated approach has been taken to assess feasible Earth to Mars missions in terms of their time and deltaV performance based on a specific set of ground rules and assumptions. Ground rules and assumptions, detailed in table 2, are those for NASA's HAT EMC Cargo missions. The intent of this study was to assess, for a wide range of years, the time divide between the major mission segments of Earth departure to escape and interplanetary transfer. To accomplish this goal, two existing trajectory simulation programs were used to model these mission segments. The OTIS program was used to generate high accuracy Earth departure spirals; the results were captured into an Earth departure spiral data surface. The Chebytop program was used to generate the Earth to Mars transfer segments. A new software program was created to manage the overall search, optimization and vehicle closure processes. This program uses the Earth spiral data surface, along with Chebytop, to perform a sweep through all the mission years of interest while optimizing departure dates and performing vehicle mass closure for all feasible missions. As described above, a multilayer search and optimization approach was taken.

The results of this study show the feasible missions for a specified SEP power level and required final payload mass at Mars. The intent is to use the graphs of total trip time and deltaV along with desired launch dates to down select missions of interest. The summary tables provide mission performance details that may be used for planning purposes. Feasible missions of interest can subsequently be analyzed in greater detail. Based on prior mission analysis experience, the overall level of fidelity in this study is deemed appropriate for the breadth of mission dates covered.

Additional parameter sweeps are planned for: power level, payload mass and Mars arrival condition. This will vastly expand the results database and will be the subject of a planned NASA Technical Data Book. To keep the present study manageable, these parameters were kept fixed. The study's goal, of showing the impact of varying mission segment times, has been demonstrated in the enclosed results.

References

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- ⁴NASA Marshall Space Flight Center, *New SLS Elliptical Orbit Performance Data 11-14-14*, November 2014, Excel spreadsheet.
- ⁵McElrath, T, et al, "USING GRAVITY ASSISTS IN THE EARTH-MOON SYSTEM AS A GATEWAY TO THE SOLAR SYSTEM," Glx-2012.05.5.2x12358, Jet Propulsion Laboratory, Pasadena, California, May 2012.
- ⁶NASA Glenn Research Center and Jet Propulsion Lab, 21000 Brookpark Rd, Cleveland, OH 44135, *Chebytop*, version 3 ed., 1969 - 2007.

Appendix A

Summary data table for End-to-End missions: EEO to Mars

HAT Cargo Mission: Total Trip Time vs Launch Date - 2026 to 2046 Range
BOL pwr= 150 kW; 10% Earth spiral degradation; E-M $1/r^2$ degradation
Mars $V_{inf} = 5.2$ km/sec; Payload= 50,000 kg

Esprl:	pwr:	150.0	m0:	70935.7	Start	2026_02_04	End	2028_01_26	mf:	62375.8	trip:	720.5	mp:	8559.8	dv:	4.0278
E-M:	pwr:	135.0	m0:	62375.8	Earth	2028_03_26	Mars	2030_01_30	mf:	57530.6	trip:	675.0	mp:	4845.3	dv:	2.5499
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7530.6	p/l:	50000.0	Ttrip:	1395.5	Tmp:	13405.1	Tdv:	6.5777
Esprl:	pwr:	150.0	m0:	68307.2	Start	2026_04_30	End	2028_01_25	mf:	60809.0	trip:	635.8	mp:	7498.2	dv:	3.6630
E-M:	pwr:	135.0	m0:	60809.0	Earth	2028_03_25	Mars	2030_03_07	mf:	57401.6	trip:	712.5	mp:	3407.4	dv:	1.8184
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7401.7	p/l:	50000.0	Ttrip:	1348.3	Tmp:	10905.6	Tdv:	5.4814
Esprl:	pwr:	150.0	m0:	68418.9	Start	2026_04_15	End	2028_01_12	mf:	60905.7	trip:	637.0	mp:	7513.1	dv:	3.6783
E-M:	pwr:	135.0	m0:	60905.7	Earth	2028_03_12	Mars	2030_04_01	mf:	57407.4	trip:	750.0	mp:	3498.3	dv:	1.8653
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7407.4	p/l:	50000.0	Ttrip:	1387.0	Tmp:	11011.4	Tdv:	5.5436
Esprl:	pwr:	150.0	m0:	70699.3	Start	2025_12_05	End	2027_11_26	mf:	62104.3	trip:	720.6	mp:	8595.0	dv:	4.0840
E-M:	pwr:	135.0	m0:	62104.3	Earth	2028_01_25	Mars	2030_03_22	mf:	57510.3	trip:	787.5	mp:	4594.0	dv:	2.4234
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7510.3	p/l:	50000.0	Ttrip:	1508.1	Tmp:	13189.0	Tdv:	6.5074
Esprl:	pwr:	150.0	m0:	72942.7	Start	2025_10_04	End	2027_11_02	mf:	63905.3	trip:	758.4	mp:	9037.4	dv:	4.0842
E-M:	pwr:	135.0	m0:	63905.3	Earth	2028_01_01	Mars	2030_04_05	mf:	57633.7	trip:	825.0	mp:	6271.7	dv:	3.2573
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7633.7	p/l:	50000.0	Ttrip:	1583.4	Tmp:	15309.0	Tdv:	7.3415
Esprl:	pwr:	150.0	m0:	72080.9	Start	2026_09_30	End	2028_10_05	mf:	63303.9	trip:	735.9	mp:	8776.9	dv:	4.0267
E-M:	pwr:	135.0	m0:	63303.9	Earth	2028_12_04	Mars	2032_01_03	mf:	57597.6	trip:	1125.0	mp:	5706.3	dv:	2.9788
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7597.6	p/l:	50000.0	Ttrip:	1860.9	Tmp:	14483.2	Tdv:	7.0056
Esprl:	pwr:	150.0	m0:	73890.8	Start	2027_02_11	End	2029_04_18	mf:	64439.3	trip:	797.2	mp:	9451.4	dv:	4.2291
E-M:	pwr:	135.0	m0:	64439.3	Earth	2029_06_17	Mars	2031_09_20	mf:	57670.2	trip:	825.0	mp:	6769.1	dv:	3.4997
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7670.2	p/l:	50000.0	Ttrip:	1622.2	Tmp:	16220.6	Tdv:	7.7289
Esprl:	pwr:	150.0	m0:	72504.8	Start	2027_03_20	End	2029_03_26	mf:	63745.6	trip:	737.1	mp:	8759.2	dv:	4.0324
E-M:	pwr:	135.0	m0:	63745.6	Earth	2029_05_25	Mars	2031_10_04	mf:	57621.9	trip:	862.5	mp:	6123.7	dv:	3.1848
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7621.9	p/l:	50000.0	Ttrip:	1599.6	Tmp:	14882.9	Tdv:	7.2172
Esprl:	pwr:	150.0	m0:	71944.3	Start	2027_03_01	End	2029_03_03	mf:	63236.4	trip:	732.9	mp:	8707.9	dv:	4.0411
E-M:	pwr:	135.0	m0:	63236.4	Earth	2029_05_02	Mars	2031_10_19	mf:	57592.1	trip:	900.0	mp:	5644.3	dv:	2.9482
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7592.1	p/l:	50000.0	Ttrip:	1632.9	Tmp:	14352.2	Tdv:	6.9894
Esprl:	pwr:	150.0	m0:	73095.0	Start	2027_02_25	End	2029_04_02	mf:	64004.1	trip:	767.3	mp:	9091.0	dv:	4.0674
E-M:	pwr:	135.0	m0:	64004.1	Earth	2029_06_01	Mars	2031_12_25	mf:	57638.5	trip:	937.5	mp:	6365.6	dv:	3.3033
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7638.5	p/l:	50000.0	Ttrip:	1704.8	Tmp:	15456.6	Tdv:	7.3707
Esprl:	pwr:	150.0	m0:	72334.2	Start	2027_03_06	End	2029_03_10	mf:	63598.9	trip:	735.1	mp:	8735.4	dv:	4.0316
E-M:	pwr:	135.0	m0:	63598.9	Earth	2029_05_09	Mars	2032_01_09	mf:	57613.7	trip:	975.0	mp:	5985.2	dv:	3.1166
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7613.7	p/l:	50000.0	Ttrip:	1710.1	Tmp:	14720.5	Tdv:	7.1482
Esprl:	pwr:	150.0	m0:	72362.4	Start	2027_02_16	End	2029_02_21	mf:	63625.1	trip:	735.3	mp:	8737.3	dv:	4.0309
E-M:	pwr:	135.0	m0:	63625.1	Earth	2029_04_22	Mars	2032_01_29	mf:	57615.2	trip:	1012.5	mp:	6009.9	dv:	3.1288
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7615.2	p/l:	50000.0	Ttrip:	1747.8	Tmp:	14747.3	Tdv:	7.1597
Esprl:	pwr:	150.0	m0:	72126.9	Start	2026_12_24	End	2028_12_30	mf:	63343.0	trip:	736.4	mp:	8783.9	dv:	4.0258
E-M:	pwr:	135.0	m0:	63343.0	Earth	2029_02_28	Mars	2032_01_14	mf:	57600.0	trip:	1050.0	mp:	5743.0	dv:	2.9970
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7600.0	p/l:	50000.0	Ttrip:	1786.4	Tmp:	14526.9	Tdv:	7.0229
Esprl:	pwr:	150.0	m0:	78266.0	Start	2026_06_19	End	2028_12_18	mf:	67439.9	trip:	913.8	mp:	10826.2	dv:	4.6887
E-M:	pwr:	135.0	m0:	67439.9	Earth	2029_02_16	Mars	2032_02_08	mf:	57922.1	trip:	1087.5	mp:	9517.7	dv:	4.7974
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7922.1	p/l:	50000.0	Ttrip:	2001.3	Tmp:	20343.9	Tdv:	9.4861
Esprl:	pwr:	150.0	m0:	80178.3	Start	2026_04_03	End	2028_11_20	mf:	68833.3	trip:	961.7	mp:	11345.1	dv:	4.7766
E-M:	pwr:	135.0	m0:	68833.3	Earth	2029_01_19	Mars	2032_02_18	mf:	58001.4	trip:	1125.0	mp:	10831.9	dv:	5.3992
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	8001.4	p/l:	50000.0	Ttrip:	2086.7	Tmp:	22176.9	Tdv:	10.1758

Esprl:	pwr:	150.0	m0:	72892.6	Start	2026_10_07	End	2028_11_02	mf:	63876.8	trip:	756.5	mp:	9015.9	dv:	4.0773
E-M:	pwr:	135.0	m0:	63876.8	Earth	2029_01_01	Mars	2032_03_08	mf:	57632.6	trip:	1162.5	mp:	6244.1	dv:	3.2438
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7632.6	p/l:	50000.0	Ttrip:	1919.0	Tmp:	15260.0	Tdv:	7.3210
Esprl:	pwr:	150.0	m0:	72002.7	Start	2028_02_11	End	2030_02_13	mf:	63290.7	trip:	733.2	mp:	8712.0	dv:	4.0397
E-M:	pwr:	135.0	m0:	63290.7	Earth	2030_04_14	Mars	2032_01_11	mf:	57595.6	trip:	637.5	mp:	5695.1	dv:	2.9734
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7595.6	p/l:	50000.0	Ttrip:	1370.7	Tmp:	14407.1	Tdv:	7.0131
Esprl:	pwr:	150.0	m0:	71454.2	Start	2028_02_01	End	2030_01_31	mf:	62783.8	trip:	729.9	mp:	8670.4	dv:	4.0518
E-M:	pwr:	135.0	m0:	62783.8	Earth	2030_04_01	Mars	2032_02_05	mf:	57561.9	trip:	675.0	mp:	5222.0	dv:	2.7383
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7561.9	p/l:	50000.0	Ttrip:	1404.9	Tmp:	13892.4	Tdv:	6.7901
Esprl:	pwr:	150.0	m0:	72147.6	Start	2027_12_22	End	2029_12_28	mf:	63360.6	trip:	736.7	mp:	8787.0	dv:	4.0254
E-M:	pwr:	135.0	m0:	63360.6	Earth	2030_02_26	Mars	2032_02_08	mf:	57600.8	trip:	712.5	mp:	5759.8	dv:	3.0053
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7600.8	p/l:	50000.0	Ttrip:	1449.2	Tmp:	14546.8	Tdv:	7.0307
Esprl:	pwr:	150.0	m0:	73296.0	Start	2027_09_22	End	2029_11_02	mf:	64106.8	trip:	771.6	mp:	9189.2	dv:	4.1334
E-M:	pwr:	135.0	m0:	64106.8	Earth	2030_01_01	Mars	2032_01_21	mf:	57646.6	trip:	750.0	mp:	6460.2	dv:	3.3495
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7646.6	p/l:	50000.0	Ttrip:	1521.6	Tmp:	15649.4	Tdv:	7.4829
Esprl:	pwr:	150.0	m0:	75192.9	Start	2029_01_05	End	2031_05_01	mf:	65151.6	trip:	846.0	mp:	10041.3	dv:	4.4939
E-M:	pwr:	135.0	m0:	65151.6	Earth	2031_06_30	Mars	2033_08_25	mf:	57736.7	trip:	787.5	mp:	7414.9	dv:	3.8100
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7736.7	p/l:	50000.0	Ttrip:	1633.5	Tmp:	17456.2	Tdv:	8.3039
Esprl:	pwr:	150.0	m0:	74369.4	Start	2029_03_13	End	2031_06_06	mf:	64701.1	trip:	815.1	mp:	9668.3	dv:	4.3265
E-M:	pwr:	135.0	m0:	64701.1	Earth	2031_08_05	Mars	2033_11_07	mf:	57693.4	trip:	825.0	mp:	7007.8	dv:	3.6149
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7693.4	p/l:	50000.0	Ttrip:	1640.1	Tmp:	16676.0	Tdv:	7.9414
Esprl:	pwr:	150.0	m0:	75223.6	Start	2029_01_08	End	2031_05_05	mf:	65168.3	trip:	847.2	mp:	10055.2	dv:	4.5001
E-M:	pwr:	135.0	m0:	65168.3	Earth	2031_07_04	Mars	2033_11_12	mf:	57738.4	trip:	862.5	mp:	7430.0	dv:	3.8172
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7738.4	p/l:	50000.0	Ttrip:	1709.7	Tmp:	17485.2	Tdv:	8.3173
Esprl:	pwr:	150.0	m0:	75664.2	Start	2028_11_20	End	2031_04_03	mf:	65409.4	trip:	863.7	mp:	10254.8	dv:	4.5897
E-M:	pwr:	135.0	m0:	65409.4	Earth	2031_06_02	Mars	2033_11_18	mf:	57761.3	trip:	900.0	mp:	7648.0	dv:	3.9211
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7761.3	p/l:	50000.0	Ttrip:	1763.7	Tmp:	17902.8	Tdv:	8.5107
Esprl:	pwr:	150.0	m0:	75991.8	Start	2028_08_20	End	2031_01_14	mf:	65590.4	trip:	876.8	mp:	10401.4	dv:	4.5458
E-M:	pwr:	135.0	m0:	65590.4	Earth	2031_03_15	Mars	2033_10_07	mf:	57776.2	trip:	937.5	mp:	7814.3	dv:	4.0001
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7776.2	p/l:	50000.0	Ttrip:	1814.3	Tmp:	18215.6	Tdv:	8.5460
Esprl:	pwr:	150.0	m0:	76586.8	Start	2028_08_01	End	2031_01_18	mf:	65905.2	trip:	900.7	mp:	10681.6	dv:	4.6335
E-M:	pwr:	135.0	m0:	65905.2	Earth	2031_03_19	Mars	2033_11_18	mf:	57805.9	trip:	975.0	mp:	8099.3	dv:	4.1349
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7805.9	p/l:	50000.0	Ttrip:	1875.7	Tmp:	18780.8	Tdv:	8.7683
Esprl:	pwr:	150.0	m0:	75361.8	Start	2028_08_26	End	2030_12_23	mf:	65284.8	trip:	849.1	mp:	10077.0	dv:	4.4211
E-M:	pwr:	135.0	m0:	65284.8	Earth	2031_02_21	Mars	2033_11_29	mf:	57748.6	trip:	1012.5	mp:	7536.2	dv:	3.8679
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7748.6	p/l:	50000.0	Ttrip:	1861.6	Tmp:	17613.2	Tdv:	8.2891
Esprl:	pwr:	150.0	m0:	75026.4	Start	2028_07_31	End	2030_11_15	mf:	65093.6	trip:	836.5	mp:	9932.8	dv:	4.3744
E-M:	pwr:	135.0	m0:	65093.6	Earth	2031_01_14	Mars	2033_11_29	mf:	57731.9	trip:	1050.0	mp:	7361.7	dv:	3.7846
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7731.9	p/l:	50000.0	Ttrip:	1886.5	Tmp:	17294.5	Tdv:	8.1590
Esprl:	pwr:	150.0	m0:	75420.0	Start	2031_02_21	End	2033_06_24	mf:	65275.8	trip:	854.5	mp:	10144.2	dv:	4.5400
E-M:	pwr:	135.0	m0:	65275.8	Earth	2033_08_23	Mars	2035_09_12	mf:	57748.0	trip:	750.0	mp:	7527.9	dv:	3.8639
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7748.0	p/l:	50000.0	Ttrip:	1604.5	Tmp:	17672.1	Tdv:	8.4040
Esprl:	pwr:	150.0	m0:	70482.2	Start	2032_02_05	End	2034_01_18	mf:	62019.0	trip:	712.4	mp:	8463.1	dv:	4.0068
E-M:	pwr:	135.0	m0:	62019.0	Earth	2034_03_19	Mars	2037_03_10	mf:	57496.7	trip:	1087.5	mp:	4522.3	dv:	2.3875
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7496.7	p/l:	50000.0	Ttrip:	1799.9	Tmp:	12985.4	Tdv:	6.3943

Esprl:	pwr: 150.0	m0: 78915.3	Start 2031_05_11	End 2033_11_14	mf: 68039.9	trip: 917.9	mp: 10875.3	dv: 4.6599
E-M:	pwr: 135.0	m0: 68039.9	Earth 2034_01_13	Mars 2037_03_20	mf: 57956.8	trip: 1162.5	mp: 10083.1	dv: 5.0579
		E_Vinf: 1.4142	M_Vinf: 5.2000	s/c: 7956.8	p/l: 50000.0	Ttrip: 2080.4	Tmp: 20958.5	Tdv: 9.7178
Esprl:	pwr: 150.0	m0: 74203.3	Start 2031_09_14	End 2033_11_28	mf: 64624.2	trip: 805.6	mp: 9579.1	dv: 4.2598
E-M:	pwr: 135.0	m0: 64624.2	Earth 2034_01_27	Mars 2037_05_11	mf: 57689.7	trip: 1200.0	mp: 6934.5	dv: 3.5794
		E_Vinf: 1.4142	M_Vinf: 5.2000	s/c: 7689.7	p/l: 50000.0	Ttrip: 2005.6	Tmp: 16513.6	Tdv: 7.8392
Esprl:	pwr: 150.0	m0: 70874.6	Start 2034_10_10	End 2036_10_01	mf: 62259.1	trip: 722.3	mp: 8615.4	dv: 4.0737
E-M:	pwr: 135.0	m0: 62259.1	Earth 2036_11_30	Mars 2039_05_19	mf: 57526.3	trip: 900.0	mp: 4732.9	dv: 2.4932
		E_Vinf: 1.4142	M_Vinf: 5.2000	s/c: 7526.3	p/l: 50000.0	Ttrip: 1622.3	Tmp: 13348.3	Tdv: 6.5669
Esprl:	pwr: 150.0	m0: 72089.7	Start 2034_09_16	End 2036_09_25	mf: 63275.3	trip: 739.9	mp: 8814.4	dv: 4.0051
E-M:	pwr: 135.0	m0: 63275.3	Earth 2036_11_24	Mars 2039_07_27	mf: 57598.4	trip: 975.0	mp: 5676.9	dv: 2.9642
		E_Vinf: 1.4142	M_Vinf: 5.2000	s/c: 7598.4	p/l: 50000.0	Ttrip: 1714.9	Tmp: 14491.3	Tdv: 6.9693
Esprl:	pwr: 150.0	m0: 71946.5	Start 2034_02_12	End 2036_02_15	mf: 63238.5	trip: 732.9	mp: 8708.0	dv: 4.0411
E-M:	pwr: 135.0	m0: 63238.5	Earth 2036_04_15	Mars 2039_01_22	mf: 57591.8	trip: 1012.5	mp: 5646.7	dv: 2.9494
		E_Vinf: 1.4142	M_Vinf: 5.2000	s/c: 7591.8	p/l: 50000.0	Ttrip: 1745.4	Tmp: 14354.7	Tdv: 6.9905
Esprl:	pwr: 150.0	m0: 68316.3	Start 2034_04_27	End 2036_01_23	mf: 60816.9	trip: 635.9	mp: 7499.4	dv: 3.6643
E-M:	pwr: 135.0	m0: 60816.9	Earth 2036_03_23	Mars 2039_03_15	mf: 57402.2	trip: 1087.5	mp: 3414.7	dv: 1.8222
		E_Vinf: 1.4142	M_Vinf: 5.2000	s/c: 7402.2	p/l: 50000.0	Ttrip: 1723.4	Tmp: 10914.1	Tdv: 5.4864
Esprl:	pwr: 150.0	m0: 77403.5	Start 2033_06_25	End 2035_12_19	mf: 66657.4	trip: 907.2	mp: 10746.1	dv: 4.6701
E-M:	pwr: 135.0	m0: 66657.4	Earth 2036_02_17	Mars 2039_03_18	mf: 57871.0	trip: 1125.0	mp: 8786.4	dv: 4.4573
		E_Vinf: 1.4142	M_Vinf: 5.2000	s/c: 7871.0	p/l: 50000.0	Ttrip: 2032.2	Tmp: 19532.5	Tdv: 9.1274
Esprl:	pwr: 150.0	m0: 71666.8	Start 2034_02_03	End 2036_02_04	mf: 62978.5	trip: 731.3	mp: 8688.3	dv: 4.0480
E-M:	pwr: 135.0	m0: 62978.5	Earth 2036_04_04	Mars 2039_06_10	mf: 57575.0	trip: 1162.5	mp: 5403.5	dv: 2.8287
		E_Vinf: 1.4142	M_Vinf: 5.2000	s/c: 7575.0	p/l: 50000.0	Ttrip: 1893.8	Tmp: 14091.8	Tdv: 6.8767
Esprl:	pwr: 150.0	m0: 68335.1	Start 2034_04_27	End 2036_01_24	mf: 60833.2	trip: 636.1	mp: 7501.9	dv: 3.6668
E-M:	pwr: 135.0	m0: 60833.2	Earth 2036_03_24	Mars 2039_07_07	mf: 57403.1	trip: 1200.0	mp: 3430.0	dv: 1.8301
		E_Vinf: 1.4142	M_Vinf: 5.2000	s/c: 7403.1	p/l: 50000.0	Ttrip: 1836.1	Tmp: 10932.0	Tdv: 5.4969
Esprl:	pwr: 150.0	m0: 71257.3	Start 2034_11_08	End 2036_11_03	mf: 62597.3	trip: 726.1	mp: 8660.1	dv: 4.0511
E-M:	pwr: 135.0	m0: 62597.3	Earth 2037_01_02	Mars 2039_06_21	mf: 57555.6	trip: 900.0	mp: 5041.6	dv: 2.6479
		E_Vinf: 1.4142	M_Vinf: 5.2000	s/c: 7555.6	p/l: 50000.0	Ttrip: 1626.1	Tmp: 13701.7	Tdv: 6.6990
Esprl:	pwr: 150.0	m0: 71387.2	Start 2034_11_06	End 2036_11_02	mf: 62712.0	trip: 727.3	mp: 8675.2	dv: 4.0435
E-M:	pwr: 135.0	m0: 62712.0	Earth 2037_01_01	Mars 2039_07_27	mf: 57562.6	trip: 937.5	mp: 5149.3	dv: 2.7018
		E_Vinf: 1.4142	M_Vinf: 5.2000	s/c: 7562.6	p/l: 50000.0	Ttrip: 1664.8	Tmp: 13824.5	Tdv: 6.7452
Esprl:	pwr: 150.0	m0: 72866.2	Start 2034_10_08	End 2036_11_02	mf: 63861.7	trip: 755.5	mp: 9004.5	dv: 4.0736
E-M:	pwr: 135.0	m0: 63861.7	Earth 2037_01_01	Mars 2039_09_03	mf: 57631.2	trip: 975.0	mp: 6230.5	dv: 3.2371
		E_Vinf: 1.4142	M_Vinf: 5.2000	s/c: 7631.2	p/l: 50000.0	Ttrip: 1730.5	Tmp: 15235.0	Tdv: 7.3107
Esprl:	pwr: 150.0	m0: 70017.8	Start 2035_10_17	End 2037_09_15	mf: 61696.9	trip: 698.4	mp: 8320.9	dv: 3.8571
E-M:	pwr: 135.0	m0: 61696.9	Earth 2037_11_14	Mars 2041_01_19	mf: 57470.6	trip: 1162.5	mp: 4226.2	dv: 2.2376
		E_Vinf: 1.4142	M_Vinf: 5.2000	s/c: 7470.6	p/l: 50000.0	Ttrip: 1860.9	Tmp: 12547.1	Tdv: 6.0947
Esprl:	pwr: 150.0	m0: 71276.5	Start 2035_07_25	End 2037_07_25	mf: 62577.4	trip: 730.3	mp: 8699.1	dv: 3.9576
E-M:	pwr: 135.0	m0: 62577.4	Earth 2037_09_23	Mars 2041_01_05	mf: 57554.0	trip: 1200.0	mp: 5023.4	dv: 2.6387
		E_Vinf: 1.4142	M_Vinf: 5.2000	s/c: 7554.0	p/l: 50000.0	Ttrip: 1930.3	Tmp: 13722.5	Tdv: 6.5963
Esprl:	pwr: 150.0	m0: 68925.6	Start 2036_12_05	End 2038_09_19	mf: 61142.2	trip: 652.8	mp: 7783.4	dv: 3.7059
E-M:	pwr: 135.0	m0: 61142.2	Earth 2038_11_18	Mars 2040_10_30	mf: 57422.7	trip: 712.5	mp: 3719.6	dv: 1.9792
		E_Vinf: 1.4142	M_Vinf: 5.2000	s/c: 7422.7	p/l: 50000.0	Ttrip: 1365.3	Tmp: 11503.0	Tdv: 5.6851

Esprl:	pwr: 150.0	m0:	70123.9	Start	2036_11_23	End	2038_10_28	mf:	61737.6	trip:	703.8	mp:	8386.3	dv:	4.0184
E-M:	pwr: 135.0	m0:	61737.6	Earth	2038_12_27	Mars	2041_03_31	mf:	57472.4	trip:	825.0	mp:	4265.2	dv:	2.2574
		E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7472.4	p/l:	50000.0	Ttrip:	1528.8	Tmp:	12651.5	Tdv:	6.2759
Esprl:	pwr: 150.0	m0:	68367.7	Start	2037_01_30	End	2038_10_24	mf:	60868.9	trip:	632.7	mp:	7498.8	dv:	3.6377
E-M:	pwr: 135.0	m0:	60868.9	Earth	2038_12_23	Mars	2041_05_03	mf:	57405.5	trip:	862.5	mp:	3463.4	dv:	1.8473
		E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7405.5	p/l:	50000.0	Ttrip:	1495.2	Tmp:	10962.2	Tdv:	5.4850
Esprl:	pwr: 150.0	m0:	69591.9	Start	2036_12_07	End	2038_10_20	mf:	61482.8	trip:	681.6	mp:	8109.1	dv:	3.8985
E-M:	pwr: 135.0	m0:	61482.8	Earth	2038_12_19	Mars	2041_06_06	mf:	57446.1	trip:	900.0	mp:	4036.7	dv:	2.1415
		E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7446.1	p/l:	50000.0	Ttrip:	1581.6	Tmp:	12145.8	Tdv:	6.0400
Esprl:	pwr: 150.0	m0:	71509.1	Start	2036_03_02	End	2038_03_03	mf:	62831.9	trip:	730.4	mp:	8677.2	dv:	4.0519
E-M:	pwr: 135.0	m0:	62831.9	Earth	2038_05_02	Mars	2041_01_01	mf:	57565.1	trip:	975.0	mp:	5266.8	dv:	2.7607
		E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7565.1	p/l:	50000.0	Ttrip:	1705.4	Tmp:	13944.0	Tdv:	6.8125
Esprl:	pwr: 150.0	m0:	68953.7	Start	2036_04_15	End	2038_02_01	mf:	61197.7	trip:	656.3	mp:	7756.0	dv:	3.7634
E-M:	pwr: 135.0	m0:	61197.7	Earth	2038_04_02	Mars	2041_01_08	mf:	57425.1	trip:	1012.5	mp:	3772.6	dv:	2.0064
		E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7425.1	p/l:	50000.0	Ttrip:	1668.8	Tmp:	11528.6	Tdv:	5.7698
Esprl:	pwr: 150.0	m0:	73278.0	Start	2036_02_07	End	2038_03_16	mf:	64154.7	trip:	768.1	mp:	9123.3	dv:	4.1463
E-M:	pwr: 135.0	m0:	64154.7	Earth	2038_05_15	Mars	2041_05_06	mf:	57644.8	trip:	1087.5	mp:	6509.9	dv:	3.3740
		E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7644.8	p/l:	50000.0	Ttrip:	1855.6	Tmp:	15633.2	Tdv:	7.5203
Esprl:	pwr: 150.0	m0:	70164.7	Start	2036_03_26	End	2038_02_25	mf:	61846.8	trip:	700.9	mp:	8317.9	dv:	3.9570
E-M:	pwr: 135.0	m0:	61846.8	Earth	2038_04_26	Mars	2041_05_25	mf:	57480.2	trip:	1125.0	mp:	4366.6	dv:	2.3089
		E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7480.2	p/l:	50000.0	Ttrip:	1825.9	Tmp:	12684.5	Tdv:	6.2659
Esprl:	pwr: 150.0	m0:	67760.3	Start	2036_05_13	End	2038_02_02	mf:	60335.2	trip:	629.7	mp:	7425.1	dv:	3.5883
E-M:	pwr: 135.0	m0:	60335.2	Earth	2038_04_03	Mars	2041_06_08	mf:	57373.5	trip:	1162.5	mp:	2961.6	dv:	1.5872
		E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7373.5	p/l:	50000.0	Ttrip:	1792.2	Tmp:	10386.7	Tdv:	5.1755
Esprl:	pwr: 150.0	m0:	67247.0	Start	2036_05_01	End	2038_01_15	mf:	59883.8	trip:	624.5	mp:	7363.1	dv:	3.5492
E-M:	pwr: 135.0	m0:	59883.8	Earth	2038_03_16	Mars	2041_06_28	mf:	57347.2	trip:	1200.0	mp:	2536.7	dv:	1.3649
		E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7347.2	p/l:	50000.0	Ttrip:	1824.5	Tmp:	9899.8	Tdv:	4.9141
Esprl:	pwr: 150.0	m0:	70151.1	Start	2036_11_28	End	2038_11_03	mf:	61750.6	trip:	705.0	mp:	8400.5	dv:	4.0245
E-M:	pwr: 135.0	m0:	61750.6	Earth	2039_01_02	Mars	2041_04_06	mf:	57473.7	trip:	825.0	mp:	4276.9	dv:	2.2633
		E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7473.7	p/l:	50000.0	Ttrip:	1530.0	Tmp:	12677.3	Tdv:	6.2879
Esprl:	pwr: 150.0	m0:	68390.0	Start	2037_02_08	End	2038_11_02	mf:	60888.7	trip:	632.9	mp:	7501.3	dv:	3.6377
E-M:	pwr: 135.0	m0:	60888.7	Earth	2039_01_01	Mars	2041_05_12	mf:	57406.7	trip:	862.5	mp:	3482.0	dv:	1.8569
		E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7406.7	p/l:	50000.0	Ttrip:	1495.4	Tmp:	10983.3	Tdv:	5.4946
Esprl:	pwr: 150.0	m0:	69664.4	Start	2036_12_17	End	2038_11_02	mf:	61517.5	trip:	684.6	mp:	8146.9	dv:	3.9149
E-M:	pwr: 135.0	m0:	61517.5	Earth	2039_01_01	Mars	2041_06_19	mf:	57449.7	trip:	900.0	mp:	4067.8	dv:	2.1573
		E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7449.7	p/l:	50000.0	Ttrip:	1584.6	Tmp:	12214.7	Tdv:	6.0721
Esprl:	pwr: 150.0	m0:	72239.7	Start	2036_10_25	End	2038_11_02	mf:	63438.7	trip:	737.9	mp:	8800.9	dv:	4.0237
E-M:	pwr: 135.0	m0:	63438.7	Earth	2039_01_01	Mars	2041_07_26	mf:	57605.2	trip:	937.5	mp:	5833.6	dv:	3.0418
		E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7605.2	p/l:	50000.0	Ttrip:	1675.4	Tmp:	14634.5	Tdv:	7.0655
Esprl:	pwr: 150.0	m0:	76663.6	Start	2037_02_23	End	2039_08_03	mf:	66094.3	trip:	891.8	mp:	10569.3	dv:	4.6466
E-M:	pwr: 135.0	m0:	66094.3	Earth	2039_10_02	Mars	2042_12_07	mf:	57818.1	trip:	1162.5	mp:	8276.2	dv:	4.2186
		E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7818.1	p/l:	50000.0	Ttrip:	2054.3	Tmp:	18845.5	Tdv:	8.8652
Esprl:	pwr: 150.0	m0:	69335.3	Start	2038_11_26	End	2040_09_26	mf:	61350.3	trip:	669.9	mp:	7985.0	dv:	3.7626
E-M:	pwr: 135.0	m0:	61350.3	Earth	2040_11_25	Mars	2042_11_07	mf:	57435.8	trip:	712.5	mp:	3914.5	dv:	2.0791
		E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7435.8	p/l:	50000.0	Ttrip:	1382.4	Tmp:	11899.5	Tdv:	5.8417

Esprl:	pwr: 150.0	m0:	73108.5	Start	2038_06_27	End	2040_08_02	mf:	63987.6	trip:	766.3	mp:	9120.9	dv:	4.1225
E-M:	pwr: 135.0	m0:	63987.6	Earth	2040_10_01	Mars	2042_10_21	mf:	57641.0	trip:	750.0	mp:	6346.6	dv:	3.2939
		E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7641.0	p/l:	50000.0	Ttrip:	1516.3	Tmp:	15467.5	Tdv:	7.4164
Esprl:	pwr: 150.0	m0:	68093.8	Start	2039_02_09	End	2040_10_31	mf:	60625.6	trip:	630.1	mp:	7468.2	dv:	3.6375
E-M:	pwr: 135.0	m0:	60625.6	Earth	2040_12_30	Mars	2043_04_04	mf:	57391.2	trip:	825.0	mp:	3234.4	dv:	1.7289
		E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7391.2	p/l:	50000.0	Ttrip:	1455.1	Tmp:	10702.6	Tdv:	5.3664
Esprl:	pwr: 150.0	m0:	69763.9	Start	2038_12_12	End	2040_10_31	mf:	61565.2	trip:	688.8	mp:	8198.8	dv:	3.9373
E-M:	pwr: 135.0	m0:	61565.2	Earth	2040_12_30	Mars	2043_05_11	mf:	57454.6	trip:	862.5	mp:	4110.6	dv:	2.1790
		E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7454.6	p/l:	50000.0	Ttrip:	1551.3	Tmp:	12309.3	Tdv:	6.1163
Esprl:	pwr: 150.0	m0:	76390.6	Start	2037_10_26	End	2040_04_04	mf:	65806.7	trip:	891.0	mp:	10583.9	dv:	4.7373
E-M:	pwr: 135.0	m0:	65806.7	Earth	2040_06_03	Mars	2042_11_20	mf:	57784.4	trip:	900.0	mp:	8022.4	dv:	4.0995
		E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7784.4	p/l:	50000.0	Ttrip:	1791.0	Tmp:	18606.3	Tdv:	8.8368
Esprl:	pwr: 150.0	m0:	71353.9	Start	2038_03_15	End	2040_03_12	mf:	62704.9	trip:	728.1	mp:	8649.0	dv:	4.0471
E-M:	pwr: 135.0	m0:	62704.9	Earth	2040_05_11	Mars	2042_12_04	mf:	57556.8	trip:	937.5	mp:	5148.1	dv:	2.7014
		E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7556.8	p/l:	50000.0	Ttrip:	1665.6	Tmp:	13797.1	Tdv:	6.7485
Esprl:	pwr: 150.0	m0:	69138.0	Start	2038_04_26	End	2040_02_18	mf:	61296.5	trip:	663.1	mp:	7841.5	dv:	3.7928
E-M:	pwr: 135.0	m0:	61296.5	Earth	2040_04_18	Mars	2042_12_19	mf:	57431.0	trip:	975.0	mp:	3865.5	dv:	2.0540
		E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7431.0	p/l:	50000.0	Ttrip:	1638.1	Tmp:	11706.9	Tdv:	5.8469
Esprl:	pwr: 150.0	m0:	75299.6	Start	2037_12_18	End	2040_04_16	mf:	65209.9	trip:	850.0	mp:	10089.6	dv:	4.5155
E-M:	pwr: 135.0	m0:	65209.9	Earth	2040_06_15	Mars	2043_03_24	mf:	57739.8	trip:	1012.5	mp:	7470.1	dv:	3.8365
		E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7739.8	p/l:	50000.0	Ttrip:	1862.5	Tmp:	17559.7	Tdv:	8.3521
Esprl:	pwr: 150.0	m0:	71735.1	Start	2038_03_20	End	2040_03_20	mf:	63042.0	trip:	731.7	mp:	8693.1	dv:	4.0463
E-M:	pwr: 135.0	m0:	63042.0	Earth	2040_05_19	Mars	2043_04_04	mf:	57579.1	trip:	1050.0	mp:	5462.9	dv:	2.8583
		E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7579.1	p/l:	50000.0	Ttrip:	1781.7	Tmp:	14156.0	Tdv:	6.9046
Esprl:	pwr: 150.0	m0:	69414.2	Start	2038_05_01	End	2040_03_05	mf:	61444.5	trip:	673.2	mp:	7969.6	dv:	3.8370
E-M:	pwr: 135.0	m0:	61444.5	Earth	2040_05_04	Mars	2043_04_26	mf:	57442.1	trip:	1087.5	mp:	4002.4	dv:	2.1240
		E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7442.1	p/l:	50000.0	Ttrip:	1760.7	Tmp:	11972.0	Tdv:	5.9610
Esprl:	pwr: 150.0	m0:	68008.4	Start	2038_05_16	End	2040_02_08	mf:	60550.1	trip:	632.4	mp:	7458.3	dv:	3.6222
E-M:	pwr: 135.0	m0:	60550.1	Earth	2040_04_08	Mars	2043_05_08	mf:	57386.1	trip:	1125.0	mp:	3164.0	dv:	1.6924
		E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7386.1	p/l:	50000.0	Ttrip:	1757.4	Tmp:	10622.3	Tdv:	5.3146
Esprl:	pwr: 150.0	m0:	67801.2	Start	2038_04_18	End	2040_01_09	mf:	60370.6	trip:	630.1	mp:	7430.6	dv:	3.5939
E-M:	pwr: 135.0	m0:	60370.6	Earth	2040_03_09	Mars	2043_05_15	mf:	57375.6	trip:	1162.5	mp:	2995.0	dv:	1.6045
		E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7375.6	p/l:	50000.0	Ttrip:	1792.6	Tmp:	10425.6	Tdv:	5.1985
Esprl:	pwr: 150.0	m0:	68643.7	Start	2038_03_04	End	2039_12_06	mf:	61028.7	trip:	642.0	mp:	7615.1	dv:	3.6848
E-M:	pwr: 135.0	m0:	61028.7	Earth	2040_02_04	Mars	2043_05_19	mf:	57414.9	trip:	1200.0	mp:	3613.8	dv:	1.9248
		E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7414.9	p/l:	50000.0	Ttrip:	1842.0	Tmp:	11228.8	Tdv:	5.6096
Esprl:	pwr: 150.0	m0:	70967.3	Start	2038_12_09	End	2040_12_02	mf:	62341.0	trip:	723.3	mp:	8626.2	dv:	4.0682
E-M:	pwr: 135.0	m0:	62341.0	Earth	2041_01_31	Mars	2043_02_20	mf:	57536.1	trip:	750.0	mp:	4804.9	dv:	2.5292
		E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7536.1	p/l:	50000.0	Ttrip:	1473.3	Tmp:	13431.2	Tdv:	6.5975
Esprl:	pwr: 150.0	m0:	67816.6	Start	2039_03_20	End	2040_12_07	mf:	60379.3	trip:	627.5	mp:	7437.3	dv:	3.6374
E-M:	pwr: 135.0	m0:	60379.3	Earth	2041_02_05	Mars	2043_04_03	mf:	57377.1	trip:	787.5	mp:	3002.2	dv:	1.6082
		E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7377.1	p/l:	50000.0	Ttrip:	1415.0	Tmp:	10439.5	Tdv:	5.2456
Esprl:	pwr: 150.0	m0:	67829.0	Start	2039_03_13	End	2040_11_30	mf:	60390.3	trip:	627.7	mp:	7438.7	dv:	3.6374
E-M:	pwr: 135.0	m0:	60390.3	Earth	2041_01_29	Mars	2043_05_04	mf:	57377.8	trip:	825.0	mp:	3012.5	dv:	1.6136
		E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7377.8	p/l:	50000.0	Ttrip:	1452.7	Tmp:	10451.2	Tdv:	5.2510

Esprl:	pwr: 150.0	m0: 69729.0	Start 2038_12_23	End 2040_11_09	mf: 61548.4	trip: 687.3	mp: 8180.5	dv: 3.9294
E-M:	pwr: 135.0	m0: 61548.4	Earth 2041_01_08	Mars 2043_05_20	mf: 57452.9	trip: 862.5	mp: 4095.6	dv: 2.1714
		E_Vinf: 1.4142	M_Vinf: 5.2000	s/c: 7452.9	p/l: 50000.0	Ttrip: 1549.8	Tmp: 12276.1	Tdv: 6.1008
Esprl:	pwr: 150.0	m0: 73753.3	Start 2038_09_05	End 2040_11_02	mf: 64367.6	trip: 788.8	mp: 9385.7	dv: 4.1971
E-M:	pwr: 135.0	m0: 64367.6	Earth 2041_01_01	Mars 2043_06_20	mf: 57660.2	trip: 900.0	mp: 6707.3	dv: 3.4700
		E_Vinf: 1.4142	M_Vinf: 5.2000	s/c: 7660.2	p/l: 50000.0	Ttrip: 1688.8	Tmp: 16093.0	Tdv: 7.6671
Esprl:	pwr: 150.0	m0: 70917.4	Start 2039_10_04	End 2041_09_28	mf: 62287.1	trip: 724.5	mp: 8630.4	dv: 3.9409
E-M:	pwr: 135.0	m0: 62287.1	Earth 2041_11_27	Mars 2045_03_11	mf: 57529.4	trip: 1200.0	mp: 4757.7	dv: 2.5056
		E_Vinf: 1.4142	M_Vinf: 5.2000	s/c: 7529.4	p/l: 50000.0	Ttrip: 1924.5	Tmp: 13388.1	Tdv: 6.4465
Esprl:	pwr: 150.0	m0: 74590.8	Start 2040_01_11	End 2042_04_14	mf: 64822.2	trip: 823.4	mp: 9768.6	dv: 4.3715
E-M:	pwr: 135.0	m0: 64822.2	Earth 2042_06_13	Mars 2044_10_22	mf: 57702.0	trip: 862.5	mp: 7120.3	dv: 3.6692
		E_Vinf: 1.4142	M_Vinf: 5.2000	s/c: 7702.0	p/l: 50000.0	Ttrip: 1685.9	Tmp: 16888.9	Tdv: 8.0406
Esprl:	pwr: 150.0	m0: 71666.7	Start 2040_03_29	End 2042_03_31	mf: 62978.4	trip: 731.3	mp: 8688.3	dv: 4.0480
E-M:	pwr: 135.0	m0: 62978.4	Earth 2042_05_30	Mars 2044_11_15	mf: 57574.8	trip: 900.0	mp: 5403.7	dv: 2.8288
		E_Vinf: 1.4142	M_Vinf: 5.2000	s/c: 7574.8	p/l: 50000.0	Ttrip: 1631.3	Tmp: 14092.0	Tdv: 6.8768
Esprl:	pwr: 150.0	m0: 70190.2	Start 2040_03_30	End 2042_03_02	mf: 61860.5	trip: 701.8	mp: 8329.7	dv: 3.9611
E-M:	pwr: 135.0	m0: 61860.5	Earth 2042_05_01	Mars 2044_11_23	mf: 57481.4	trip: 937.5	mp: 4379.1	dv: 2.3152
		E_Vinf: 1.4142	M_Vinf: 5.2000	s/c: 7481.4	p/l: 50000.0	Ttrip: 1639.3	Tmp: 12708.8	Tdv: 6.2763
Esprl:	pwr: 150.0	m0: 69077.8	Start 2040_04_16	End 2042_02_06	mf: 61264.2	trip: 660.9	mp: 7813.5	dv: 3.7832
E-M:	pwr: 135.0	m0: 61264.2	Earth 2042_04_07	Mars 2044_12_07	mf: 57429.1	trip: 975.0	mp: 3835.1	dv: 2.0385
		E_Vinf: 1.4142	M_Vinf: 5.2000	s/c: 7429.1	p/l: 50000.0	Ttrip: 1635.9	Tmp: 11648.7	Tdv: 5.8217
Esprl:	pwr: 150.0	m0: 69190.4	Start 2040_03_10	End 2042_01_04	mf: 61324.6	trip: 665.0	mp: 7865.8	dv: 3.8012
E-M:	pwr: 135.0	m0: 61324.6	Earth 2042_03_05	Mars 2044_12_11	mf: 57432.7	trip: 1012.5	mp: 3891.8	dv: 2.0675
		E_Vinf: 1.4142	M_Vinf: 5.2000	s/c: 7432.7	p/l: 50000.0	Ttrip: 1677.5	Tmp: 11757.6	Tdv: 5.8688
Esprl:	pwr: 150.0	m0: 70229.7	Start 2040_04_02	End 2042_03_06	mf: 61881.6	trip: 703.2	mp: 8348.0	dv: 3.9674
E-M:	pwr: 135.0	m0: 61881.6	Earth 2042_05_05	Mars 2045_03_20	mf: 57483.9	trip: 1050.0	mp: 4397.8	dv: 2.3246
		E_Vinf: 1.4142	M_Vinf: 5.2000	s/c: 7483.9	p/l: 50000.0	Ttrip: 1753.2	Tmp: 12745.8	Tdv: 6.2920
Esprl:	pwr: 150.0	m0: 69211.1	Start 2040_04_07	End 2042_02_02	mf: 61335.7	trip: 665.8	mp: 7875.4	dv: 3.8045
E-M:	pwr: 135.0	m0: 61335.7	Earth 2042_04_03	Mars 2045_03_25	mf: 57433.4	trip: 1087.5	mp: 3902.3	dv: 2.0729
		E_Vinf: 1.4142	M_Vinf: 5.2000	s/c: 7433.4	p/l: 50000.0	Ttrip: 1753.3	Tmp: 11777.7	Tdv: 5.8774
Esprl:	pwr: 150.0	m0: 69304.8	Start 2040_03_03	End 2042_01_01	mf: 61385.9	trip: 669.2	mp: 7918.9	dv: 3.8195
E-M:	pwr: 135.0	m0: 61385.9	Earth 2042_03_02	Mars 2045_03_31	mf: 57436.8	trip: 1125.0	mp: 3949.1	dv: 2.0968
		E_Vinf: 1.4142	M_Vinf: 5.2000	s/c: 7436.8	p/l: 50000.0	Ttrip: 1794.2	Tmp: 11868.0	Tdv: 5.9164
Esprl:	pwr: 150.0	m0: 70563.6	Start 2039_12_04	End 2041_11_22	mf: 61984.4	trip: 719.3	mp: 8579.2	dv: 4.0920
E-M:	pwr: 135.0	m0: 61984.4	Earth 2042_01_21	Mars 2045_03_28	mf: 57498.7	trip: 1162.5	mp: 4485.7	dv: 2.3688
		E_Vinf: 1.4142	M_Vinf: 5.2000	s/c: 7498.7	p/l: 50000.0	Ttrip: 1881.8	Tmp: 13064.8	Tdv: 6.4608
Esprl:	pwr: 150.0	m0: 71124.1	Start 2039_11_08	End 2041_11_02	mf: 62479.5	trip: 724.8	mp: 8644.5	dv: 4.0590
E-M:	pwr: 135.0	m0: 62479.5	Earth 2042_01_01	Mars 2045_04_15	mf: 57549.0	trip: 1200.0	mp: 4930.6	dv: 2.5922
		E_Vinf: 1.4142	M_Vinf: 5.2000	s/c: 7549.0	p/l: 50000.0	Ttrip: 1924.8	Tmp: 13575.1	Tdv: 6.6511
Esprl:	pwr: 150.0	m0: 69048.1	Start 2041_03_27	End 2043_01_15	mf: 61248.3	trip: 659.8	mp: 7799.8	dv: 3.7785
E-M:	pwr: 135.0	m0: 61248.3	Earth 2043_03_16	Mars 2045_02_25	mf: 57428.1	trip: 712.5	mp: 3820.2	dv: 2.0309
		E_Vinf: 1.4142	M_Vinf: 5.2000	s/c: 7428.1	p/l: 50000.0	Ttrip: 1372.3	Tmp: 11620.0	Tdv: 5.8093
Esprl:	pwr: 150.0	m0: 67565.8	Start 2041_04_25	End 2043_01_13	mf: 60166.7	trip: 627.5	mp: 7399.1	dv: 3.5618
E-M:	pwr: 135.0	m0: 60166.7	Earth 2043_03_14	Mars 2045_04_02	mf: 57363.7	trip: 750.0	mp: 2803.1	dv: 1.5044
		E_Vinf: 1.4142	M_Vinf: 5.2000	s/c: 7363.7	p/l: 50000.0	Ttrip: 1377.5	Tmp: 10202.2	Tdv: 5.0662

Esprl:	pwr:	150.0	m0:	68392.1	Start	2041_03_31	End	2042_12_24	mf:	60890.6	trip:	632.9	mp:	7501.5	dv:	3.6377
E-M:	pwr:	135.0	m0:	60890.6	Earth	2043_02_22	Mars	2045_04_19	mf:	57406.8	trip:	787.5	mp:	3483.8	dv:	1.8578
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7406.8	p/l:	50000.0	Ttrip:	1420.4	Tmp:	10985.3	Tdv:	5.4956
Esprl:	pwr:	150.0	m0:	71001.7	Start	2040_11_08	End	2042_11_02	mf:	62371.5	trip:	723.6	mp:	8630.3	dv:	4.0662
E-M:	pwr:	135.0	m0:	62371.5	Earth	2043_01_01	Mars	2045_04_05	mf:	57538.4	trip:	825.0	mp:	4833.1	dv:	2.5434
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7538.4	p/l:	50000.0	Ttrip:	1548.6	Tmp:	13463.4	Tdv:	6.6096
Esprl:	pwr:	150.0	m0:	71769.9	Start	2041_10_28	End	2043_10_30	mf:	63039.9	trip:	731.9	mp:	8730.0	dv:	4.0327
E-M:	pwr:	135.0	m0:	63039.9	Earth	2043_12_29	Mars	2047_01_27	mf:	57582.0	trip:	1125.0	mp:	5457.9	dv:	2.8556
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7582.0	p/l:	50000.0	Ttrip:	1856.9	Tmp:	14187.8	Tdv:	6.8883
Esprl:	pwr:	150.0	m0:	71620.3	Start	2041_08_13	End	2043_08_19	mf:	62864.9	trip:	735.0	mp:	8755.4	dv:	3.9759
E-M:	pwr:	135.0	m0:	62864.9	Earth	2043_10_18	Mars	2047_01_30	mf:	57572.6	trip:	1200.0	mp:	5292.3	dv:	2.7731
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7572.6	p/l:	50000.0	Ttrip:	1935.0	Tmp:	14047.7	Tdv:	6.7490
Esprl:	pwr:	150.0	m0:	72970.6	Start	2042_08_27	End	2044_09_27	mf:	63905.9	trip:	761.4	mp:	9064.7	dv:	4.1022
E-M:	pwr:	135.0	m0:	63905.9	Earth	2044_11_26	Mars	2047_01_22	mf:	57636.3	trip:	787.5	mp:	6269.6	dv:	3.2561
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7636.3	p/l:	50000.0	Ttrip:	1548.9	Tmp:	15334.3	Tdv:	7.3583
Esprl:	pwr:	150.0	m0:	74645.8	Start	2042_02_01	End	2044_05_07	mf:	64852.3	trip:	825.5	mp:	9793.5	dv:	4.3826
E-M:	pwr:	135.0	m0:	64852.3	Earth	2044_07_06	Mars	2046_10_09	mf:	57706.8	trip:	825.0	mp:	7145.5	dv:	3.6812
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7706.8	p/l:	50000.0	Ttrip:	1650.5	Tmp:	16939.0	Tdv:	8.0638
Esprl:	pwr:	150.0	m0:	72421.2	Start	2042_03_24	End	2044_03_28	mf:	63679.7	trip:	735.6	mp:	8741.5	dv:	4.0294
E-M:	pwr:	135.0	m0:	63679.7	Earth	2044_05_27	Mars	2046_10_06	mf:	57618.2	trip:	862.5	mp:	6061.5	dv:	3.1542
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7618.2	p/l:	50000.0	Ttrip:	1598.1	Tmp:	14803.0	Tdv:	7.1837
Esprl:	pwr:	150.0	m0:	71597.6	Start	2042_03_07	End	2044_03_07	mf:	62914.1	trip:	730.9	mp:	8683.4	dv:	4.0497
E-M:	pwr:	135.0	m0:	62914.1	Earth	2044_05_06	Mars	2046_10_23	mf:	57570.8	trip:	900.0	mp:	5343.3	dv:	2.7988
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7570.8	p/l:	50000.0	Ttrip:	1630.9	Tmp:	14026.7	Tdv:	6.8485
Esprl:	pwr:	150.0	m0:	71041.6	Start	2042_02_23	End	2044_02_15	mf:	62459.2	trip:	722.4	mp:	8582.4	dv:	4.0327
E-M:	pwr:	135.0	m0:	62459.2	Earth	2044_04_15	Mars	2046_11_08	mf:	57538.5	trip:	937.5	mp:	4920.7	dv:	2.5876
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7538.5	p/l:	50000.0	Ttrip:	1659.9	Tmp:	13503.1	Tdv:	6.6203
Esprl:	pwr:	150.0	m0:	71188.4	Start	2042_01_17	End	2044_01_12	mf:	62574.7	trip:	725.1	mp:	8613.7	dv:	4.0395
E-M:	pwr:	135.0	m0:	62574.7	Earth	2044_03_12	Mars	2046_11_12	mf:	57548.5	trip:	975.0	mp:	5026.2	dv:	2.6404
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7548.5	p/l:	50000.0	Ttrip:	1700.1	Tmp:	13639.9	Tdv:	6.6799
Esprl:	pwr:	150.0	m0:	71587.0	Start	2042_02_28	End	2044_02_29	mf:	62904.3	trip:	730.9	mp:	8682.7	dv:	4.0499
E-M:	pwr:	135.0	m0:	62904.3	Earth	2044_04_29	Mars	2047_02_05	mf:	57570.3	trip:	1012.5	mp:	5334.1	dv:	2.7942
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7570.3	p/l:	50000.0	Ttrip:	1743.4	Tmp:	14016.7	Tdv:	6.8441
Esprl:	pwr:	150.0	m0:	71425.8	Start	2042_01_06	End	2044_01_05	mf:	62761.5	trip:	729.3	mp:	8664.3	dv:	4.0505
E-M:	pwr:	135.0	m0:	62761.5	Earth	2044_03_05	Mars	2047_01_19	mf:	57560.8	trip:	1050.0	mp:	5200.6	dv:	2.7276
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7560.8	p/l:	50000.0	Ttrip:	1779.3	Tmp:	13865.0	Tdv:	6.7781
Esprl:	pwr:	150.0	m0:	71464.9	Start	2041_12_11	End	2043_12_09	mf:	62780.7	trip:	728.1	mp:	8684.3	dv:	4.0389
E-M:	pwr:	135.0	m0:	62780.7	Earth	2044_02_07	Mars	2047_01_29	mf:	57566.7	trip:	1087.5	mp:	5214.0	dv:	2.7341
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7566.7	p/l:	50000.0	Ttrip:	1815.6	Tmp:	13898.2	Tdv:	6.7729
Esprl:	pwr:	150.0	m0:	71775.9	Start	2041_11_01	End	2043_11_03	mf:	63045.0	trip:	732.0	mp:	8730.9	dv:	4.0325
E-M:	pwr:	135.0	m0:	63045.0	Earth	2044_01_02	Mars	2047_01_31	mf:	57582.3	trip:	1125.0	mp:	5462.7	dv:	2.8580
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7582.3	p/l:	50000.0	Ttrip:	1857.0	Tmp:	14193.5	Tdv:	6.8905
Esprl:	pwr:	150.0	m0:	72042.5	Start	2041_10_27	End	2043_11_02	mf:	63271.3	trip:	735.4	mp:	8771.1	dv:	4.0274
E-M:	pwr:	135.0	m0:	63271.3	Earth	2044_01_01	Mars	2047_03_08	mf:	57595.7	trip:	1162.5	mp:	5675.6	dv:	2.9637
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7595.7	p/l:	50000.0	Ttrip:	1897.9	Tmp:	14446.8	Tdv:	6.9911

Esprl:	pwr:	150.0	m0:	72028.5	Start	2043_02_08	End	2045_02_10	mf:	63314.7	trip:	733.4	mp:	8713.8	dv:	4.0391
E-M:	pwr:	135.0	m0:	63314.7	Earth	2045_04_11	Mars	2047_01_08	mf:	57597.3	trip:	637.5	mp:	5717.4	dv:	2.9844
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7597.3	p/l:	50000.0	Ttrip:	1370.9	Tmp:	14431.2	Tdv:	7.0235
Esprl:	pwr:	150.0	m0:	70141.0	Start	2043_03_07	End	2045_02_04	mf:	61834.1	trip:	700.0	mp:	8306.9	dv:	3.9532
E-M:	pwr:	135.0	m0:	61834.1	Earth	2045_04_05	Mars	2047_02_09	mf:	57479.0	trip:	675.0	mp:	4355.1	dv:	2.3031
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7479.0	p/l:	50000.0	Ttrip:	1375.0	Tmp:	12662.0	Tdv:	6.2563
Esprl:	pwr:	150.0	m0:	70203.3	Start	2043_02_14	End	2045_01_17	mf:	61867.5	trip:	702.3	mp:	8335.8	dv:	3.9632
E-M:	pwr:	135.0	m0:	61867.5	Earth	2045_03_18	Mars	2047_02_28	mf:	57482.2	trip:	712.5	mp:	4385.3	dv:	2.3184
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7482.2	p/l:	50000.0	Ttrip:	1414.8	Tmp:	12721.1	Tdv:	6.2815
Esprl:	pwr:	150.0	m0:	71587.6	Start	2042_12_05	End	2044_12_03	mf:	62885.1	trip:	729.6	mp:	8702.4	dv:	4.0361
E-M:	pwr:	135.0	m0:	62885.1	Earth	2045_02_01	Mars	2047_02_21	mf:	57572.8	trip:	750.0	mp:	5312.3	dv:	2.7831
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7572.8	p/l:	50000.0	Ttrip:	1479.6	Tmp:	14014.8	Tdv:	6.8193
Esprl:	pwr:	150.0	m0:	73278.1	Start	2042_09_23	End	2044_11_02	mf:	64096.6	trip:	770.9	mp:	9181.5	dv:	4.1310
E-M:	pwr:	135.0	m0:	64096.6	Earth	2045_01_01	Mars	2047_02_27	mf:	57645.8	trip:	787.5	mp:	6450.8	dv:	3.3449
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7645.8	p/l:	50000.0	Ttrip:	1558.4	Tmp:	15632.3	Tdv:	7.4758
Esprl:	pwr:	150.0	m0:	74775.9	Start	2044_01_21	End	2046_04_30	mf:	64923.5	trip:	830.4	mp:	9852.4	dv:	4.4091
E-M:	pwr:	135.0	m0:	64923.5	Earth	2046_06_29	Mars	2048_08_24	mf:	57714.9	trip:	787.5	mp:	7208.6	dv:	3.7113
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7714.9	p/l:	50000.0	Ttrip:	1617.9	Tmp:	17061.0	Tdv:	8.1204
Esprl:	pwr:	150.0	m0:	74013.0	Start	2044_04_01	End	2046_06_12	mf:	64506.2	trip:	801.7	mp:	9506.8	dv:	4.2540
E-M:	pwr:	135.0	m0:	64506.2	Earth	2046_08_11	Mars	2048_11_13	mf:	57674.1	trip:	825.0	mp:	6832.1	dv:	3.5303
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7674.1	p/l:	50000.0	Ttrip:	1626.7	Tmp:	16338.9	Tdv:	7.7843
Esprl:	pwr:	150.0	m0:	73618.0	Start	2044_01_28	End	2046_03_20	mf:	64334.6	trip:	781.7	mp:	9283.5	dv:	4.1963
E-M:	pwr:	135.0	m0:	64334.6	Earth	2046_05_19	Mars	2048_09_27	mf:	57656.0	trip:	862.5	mp:	6678.6	dv:	3.4562
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7656.0	p/l:	50000.0	Ttrip:	1644.2	Tmp:	15962.0	Tdv:	7.6525
Esprl:	pwr:	150.0	m0:	73475.6	Start	2044_01_12	End	2046_02_26	mf:	64259.2	trip:	776.0	mp:	9216.4	dv:	4.1754
E-M:	pwr:	135.0	m0:	64259.2	Earth	2046_04_27	Mars	2048_10_13	mf:	57650.8	trip:	900.0	mp:	6608.4	dv:	3.4221
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7650.8	p/l:	50000.0	Ttrip:	1676.0	Tmp:	15824.8	Tdv:	7.5974
Esprl:	pwr:	150.0	m0:	73943.4	Start	2043_11_14	End	2046_01_17	mf:	64506.7	trip:	794.8	mp:	9436.7	dv:	4.2442
E-M:	pwr:	135.0	m0:	64506.7	Earth	2046_03_18	Mars	2048_10_10	mf:	57672.6	trip:	937.5	mp:	6834.2	dv:	3.5314
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7672.6	p/l:	50000.0	Ttrip:	1732.3	Tmp:	16270.9	Tdv:	7.7756
Esprl:	pwr:	150.0	m0:	74029.2	Start	2043_09_29	End	2045_12_06	mf:	64524.9	trip:	799.1	mp:	9504.3	dv:	4.2355
E-M:	pwr:	135.0	m0:	64524.9	Earth	2046_02_04	Mars	2048_10_06	mf:	57681.1	trip:	975.0	mp:	6843.8	dv:	3.5356
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7681.1	p/l:	50000.0	Ttrip:	1774.1	Tmp:	16348.1	Tdv:	7.7711
Esprl:	pwr:	150.0	m0:	73959.4	Start	2043_10_29	End	2046_01_02	mf:	64515.2	trip:	795.4	mp:	9444.2	dv:	4.2466
E-M:	pwr:	135.0	m0:	64515.2	Earth	2046_03_03	Mars	2048_12_09	mf:	57673.5	trip:	1012.5	mp:	6841.7	dv:	3.5350
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7673.5	p/l:	50000.0	Ttrip:	1807.9	Tmp:	16285.9	Tdv:	7.7816
Esprl:	pwr:	150.0	m0:	77810.2	Start	2043_06_23	End	2045_12_20	mf:	67019.6	trip:	910.9	mp:	10790.5	dv:	4.7046
E-M:	pwr:	135.0	m0:	67019.6	Earth	2046_02_18	Mars	2049_01_03	mf:	57897.6	trip:	1050.0	mp:	9122.0	dv:	4.6137
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7897.6	p/l:	50000.0	Ttrip:	1960.9	Tmp:	19912.6	Tdv:	9.3183
Esprl:	pwr:	150.0	m0:	73480.2	Start	2043_09_16	End	2045_11_02	mf:	64211.9	trip:	778.5	mp:	9268.4	dv:	4.1591
E-M:	pwr:	135.0	m0:	64211.9	Earth	2046_01_01	Mars	2048_12_23	mf:	57653.3	trip:	1087.5	mp:	6558.6	dv:	3.3975
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7653.3	p/l:	50000.0	Ttrip:	1866.0	Tmp:	15827.0	Tdv:	7.5566
Esprl:	pwr:	150.0	m0:	75302.8	Start	2046_02_25	End	2048_06_24	mf:	65211.7	trip:	850.1	mp:	10091.1	dv:	4.5162
E-M:	pwr:	135.0	m0:	65211.7	Earth	2048_08_23	Mars	2050_09_12	mf:	57742.2	trip:	750.0	mp:	7469.5	dv:	3.8361
			E_Vinf:	1.4142	M_Vinf:	5.2000	s/c:	7742.2	p/l:	50000.0	Ttrip:	1600.1	Tmp:	17560.6	Tdv:	8.3523

Esprl:	pwr: 150.0	m0: 74985.5	Start 2046_02_28	End 2048_06_15	mf: 65038.1	trip: 838.2	mp: 9947.4	dv: 4.4517
E-M:	pwr: 135.0	m0: 65038.1	Earth 2048_08_14	Mars 2050_10_10	mf: 57725.3	trip: 787.5	mp: 7312.8	dv: 3.7613
		E_Vinf: 1.4142	M_Vinf: 5.2000	s/c: 7725.3	p/l: 50000.0	Ttrip: 1625.7	Tmp: 17260.2	Tdv: 8.2129
Esprl:	pwr: 150.0	m0: 76685.4	Start 2045_12_05	End 2048_05_25	mf: 65968.0	trip: 902.0	mp: 10717.4	dv: 4.7973
E-M:	pwr: 135.0	m0: 65968.0	Earth 2048_07_24	Mars 2050_10_27	mf: 57811.6	trip: 825.0	mp: 8156.4	dv: 4.1618
		E_Vinf: 1.4142	M_Vinf: 5.2000	s/c: 7811.6	p/l: 50000.0	Ttrip: 1727.0	Tmp: 18873.8	Tdv: 8.9591

Appendix B

Summary data table for interplanetary-only missions: Earth Escape to Mars

HAT Cargo Mission: Total Trip Time vs Earth Escape Date ($C_3 = +2.0$
 km^2/sec^2) - 2028 to 2048 Range
BOL pwr= 135 kW; E-M $1/r^2$ degradation
Mars $V_{inf} = 5.2$ km/sec; Payload= 50,000 kg

E-M:	pwr: 135.0	m0: 61857.2 E_Vinf: 1.4142	Earth 2028_03_26 M_Vinf: 5.2000	Mars 2030_01_30 s/c: 7067.9	mf: 57067.9 p/l: 50000.0	trip: 675.0 Ttrip: 675.0	mp: 4789.3 Tmp: 4789.3	dv: 2.5412 Tdv: 2.5412
E-M:	pwr: 135.0	m0: 60358.1 E_Vinf: 1.4142	Earth 2028_03_26 M_Vinf: 5.2000	Mars 2030_03_08 s/c: 6989.4	mf: 56989.4 p/l: 50000.0	trip: 712.5 Ttrip: 712.5	mp: 3368.7 Tmp: 3368.7	dv: 1.8110 Tdv: 1.8110
E-M:	pwr: 135.0	m0: 60451.8 E_Vinf: 1.4142	Earth 2028_03_12 M_Vinf: 5.2000	Mars 2030_04_01 s/c: 6994.3	mf: 56994.3 p/l: 50000.0	trip: 750.0 Ttrip: 750.0	mp: 3457.5 Tmp: 3457.5	dv: 1.8572 Tdv: 1.8572
E-M:	pwr: 135.0	m0: 61580.1 E_Vinf: 1.4142	Earth 2028_01_27 M_Vinf: 5.2000	Mars 2030_03_24 s/c: 7053.4	mf: 57053.4 p/l: 50000.0	trip: 787.5 Ttrip: 787.5	mp: 4526.8 Tmp: 4526.8	dv: 2.4077 Tdv: 2.4077
E-M:	pwr: 135.0	m0: 63252.1 E_Vinf: 1.4142	Earth 2028_01_01 M_Vinf: 5.2000	Mars 2030_04_05 s/c: 7140.8	mf: 57140.8 p/l: 50000.0	trip: 825.0 Ttrip: 825.0	mp: 6111.3 Tmp: 6111.3	dv: 3.2041 Tdv: 3.2041
E-M:	pwr: 135.0	m0: 62233.7 E_Vinf: 1.4142	Earth 2028_10_22 M_Vinf: 5.2000	Mars 2031_10_14 s/c: 7087.6	mf: 57087.6 p/l: 50000.0	trip: 1087.5 Ttrip: 1087.5	mp: 5146.2 Tmp: 5146.2	dv: 2.7217 Tdv: 2.7217
E-M:	pwr: 135.0	m0: 62752.0 E_Vinf: 1.4142	Earth 2028_12_04 M_Vinf: 5.2000	Mars 2032_01_03 s/c: 7114.7	mf: 57114.7 p/l: 50000.0	trip: 1125.0 Ttrip: 1125.0	mp: 5637.3 Tmp: 5637.3	dv: 2.9682 Tdv: 2.9682
E-M:	pwr: 135.0	m0: 63812.0 E_Vinf: 1.4142	Earth 2029_06_17 M_Vinf: 5.2000	Mars 2031_09_20 s/c: 7170.1	mf: 57170.1 p/l: 50000.0	trip: 825.0 Ttrip: 825.0	mp: 6641.8 Tmp: 6641.8	dv: 3.4658 Tdv: 3.4658
E-M:	pwr: 135.0	m0: 63169.6 E_Vinf: 1.4142	Earth 2029_05_25 M_Vinf: 5.2000	Mars 2031_10_04 s/c: 7136.5	mf: 57136.5 p/l: 50000.0	trip: 862.5 Ttrip: 862.5	mp: 6033.1 Tmp: 6033.1	dv: 3.1653 Tdv: 3.1653
E-M:	pwr: 135.0	m0: 62681.5 E_Vinf: 1.4142	Earth 2029_05_02 M_Vinf: 5.2000	Mars 2031_10_19 s/c: 7111.0	mf: 57111.0 p/l: 50000.0	trip: 900.0 Ttrip: 900.0	mp: 5570.5 Tmp: 5570.5	dv: 2.9348 Tdv: 2.9348
E-M:	pwr: 135.0	m0: 63409.6 E_Vinf: 1.4142	Earth 2029_06_03 M_Vinf: 5.2000	Mars 2031_12_27 s/c: 7149.1	mf: 57149.1 p/l: 50000.0	trip: 937.5 Ttrip: 937.5	mp: 6260.6 Tmp: 6260.6	dv: 3.2780 Tdv: 3.2780
E-M:	pwr: 135.0	m0: 63042.0 E_Vinf: 1.4142	Earth 2029_05_07 M_Vinf: 5.2000	Mars 2032_01_07 s/c: 7129.8	mf: 57129.8 p/l: 50000.0	trip: 975.0 Ttrip: 975.0	mp: 5912.2 Tmp: 5912.2	dv: 3.1053 Tdv: 3.1053
E-M:	pwr: 135.0	m0: 63061.9 E_Vinf: 1.4142	Earth 2029_04_21 M_Vinf: 5.2000	Mars 2032_01_28 s/c: 7130.9	mf: 57130.9 p/l: 50000.0	trip: 1012.5 Ttrip: 1012.5	mp: 5931.0 Tmp: 5931.0	dv: 3.1146 Tdv: 3.1146
E-M:	pwr: 135.0	m0: 62759.0 E_Vinf: 1.4142	Earth 2029_02_26 M_Vinf: 5.2000	Mars 2032_01_12 s/c: 7115.0	mf: 57115.0 p/l: 50000.0	trip: 1050.0 Ttrip: 1050.0	mp: 5644.0 Tmp: 5644.0	dv: 2.9716 Tdv: 2.9716
E-M:	pwr: 135.0	m0: 66668.4 E_Vinf: 1.4142	Earth 2029_02_16 M_Vinf: 5.2000	Mars 2032_02_08 s/c: 7319.5	mf: 57319.5 p/l: 50000.0	trip: 1087.5 Ttrip: 1087.5	mp: 9348.9 Tmp: 9348.9	dv: 4.7644 Tdv: 4.7644
E-M:	pwr: 135.0	m0: 67968.9 E_Vinf: 1.4142	Earth 2029_01_19 M_Vinf: 5.2000	Mars 2032_02_18 s/c: 7387.6	mf: 57387.6 p/l: 50000.0	trip: 1125.0 Ttrip: 1125.0	mp: 10581.3 Tmp: 10581.3	dv: 5.3362 Tdv: 5.3362
E-M:	pwr: 135.0	m0: 63303.3 E_Vinf: 1.4142	Earth 2029_01_01 M_Vinf: 5.2000	Mars 2032_03_08 s/c: 7143.5	mf: 57143.5 p/l: 50000.0	trip: 1162.5 Ttrip: 1162.5	mp: 6159.8 Tmp: 6159.8	dv: 3.2282 Tdv: 3.2282
E-M:	pwr: 135.0	m0: 62724.8 E_Vinf: 1.4142	Earth 2030_04_14 M_Vinf: 5.2000	Mars 2032_01_11 s/c: 7113.2	mf: 57113.2 p/l: 50000.0	trip: 637.5 Ttrip: 637.5	mp: 5611.6 Tmp: 5611.6	dv: 2.9554 Tdv: 2.9554
E-M:	pwr: 135.0	m0: 62217.1 E_Vinf: 1.4142	Earth 2030_04_01 M_Vinf: 5.2000	Mars 2032_02_05 s/c: 7086.7	mf: 57086.7 p/l: 50000.0	trip: 675.0 Ttrip: 675.0	mp: 5130.5 Tmp: 5130.5	dv: 2.7138 Tdv: 2.7138
E-M:	pwr: 135.0	m0: 62749.8 E_Vinf: 1.4142	Earth 2030_02_25 M_Vinf: 5.2000	Mars 2032_02_07 s/c: 7114.6	mf: 57114.5 p/l: 50000.0	trip: 712.5 Ttrip: 712.5	mp: 5635.2 Tmp: 5635.2	dv: 2.9672 Tdv: 2.9672

E-M:	pwr: 135.0	m0: 63511.7 E_Vinf: 1.4142	Earth 2030_01_01 M_Vinf: 5.2000	Mars 2032_01_21 s/c: 7154.4	mf: p/l: 57154.4 50000.0	trip: 750.0 Ttrip: 750.0	mp: 6357.3 dv: 3.3258 Tmp: 6357.3 Tdv: 3.3258
E-M:	pwr: 135.0	m0: 64486.9 E_Vinf: 1.4142	Earth 2031_06_30 M_Vinf: 5.2000	Mars 2033_08_25 s/c: 7205.4	mf: p/l: 57205.4 50000.0	trip: 787.5 Ttrip: 787.5	mp: 7281.5 dv: 3.7782 Tmp: 7281.5 Tdv: 3.7782
E-M:	pwr: 135.0	m0: 64031.5 E_Vinf: 1.4142	Earth 2031_08_05 M_Vinf: 5.2000	Mars 2033_11_07 s/c: 7181.6	mf: p/l: 57181.6 50000.0	trip: 825.0 Ttrip: 825.0	mp: 6849.9 dv: 3.5678 Tmp: 6849.9 Tdv: 3.5678
E-M:	pwr: 135.0	m0: 64517.2 E_Vinf: 1.4142	Earth 2031_06_30 M_Vinf: 5.2000	Mars 2033_11_08 s/c: 7207.0	mf: p/l: 57207.0 50000.0	trip: 862.5 Ttrip: 862.5	mp: 7310.2 dv: 3.7921 Tmp: 7310.2 Tdv: 3.7921
E-M:	pwr: 135.0	m0: 64745.0 E_Vinf: 1.4142	Earth 2031_06_02 M_Vinf: 5.2000	Mars 2033_11_18 s/c: 7218.9	mf: p/l: 57218.9 50000.0	trip: 900.0 Ttrip: 900.0	mp: 7526.1 dv: 3.8967 Tmp: 7526.1 Tdv: 3.8967
E-M:	pwr: 135.0	m0: 64922.4 E_Vinf: 1.4142	Earth 2031_03_15 M_Vinf: 5.2000	Mars 2033_10_07 s/c: 7228.2	mf: p/l: 57228.2 50000.0	trip: 937.5 Ttrip: 937.5	mp: 7694.2 dv: 3.9778 Tmp: 7694.2 Tdv: 3.9778
E-M:	pwr: 135.0	m0: 65199.6 E_Vinf: 1.4142	Earth 2031_03_20 M_Vinf: 5.2000	Mars 2033_11_19 s/c: 7242.7	mf: p/l: 57242.7 50000.0	trip: 975.0 Ttrip: 975.0	mp: 7956.9 dv: 4.1042 Tmp: 7956.9 Tdv: 4.1042
E-M:	pwr: 135.0	m0: 64632.7 E_Vinf: 1.4142	Earth 2031_02_21 M_Vinf: 5.2000	Mars 2033_11_29 s/c: 7213.1	mf: p/l: 57213.0 50000.0	trip: 1012.5 Ttrip: 1012.5	mp: 7419.7 dv: 3.8452 Tmp: 7419.7 Tdv: 3.8452
E-M:	pwr: 135.0	m0: 64461.8 E_Vinf: 1.4142	Earth 2031_01_14 M_Vinf: 5.2000	Mars 2033_11_29 s/c: 7204.1	mf: p/l: 57204.1 50000.0	trip: 1050.0 Ttrip: 1050.0	mp: 7257.7 dv: 3.7666 Tmp: 7257.7 Tdv: 3.7666
E-M:	pwr: 135.0	m0: 64597.2 E_Vinf: 1.4142	Earth 2033_08_23 M_Vinf: 5.2000	Mars 2035_09_12 s/c: 7211.2	mf: p/l: 57211.2 50000.0	trip: 750.0 Ttrip: 750.0	mp: 7386.0 dv: 3.8289 Tmp: 7386.0 Tdv: 3.8289
E-M:	pwr: 135.0	m0: 61522.0 E_Vinf: 1.4142	Earth 2034_03_19 M_Vinf: 5.2000	Mars 2037_03_10 s/c: 7050.3	mf: p/l: 57050.3 50000.0	trip: 1087.5 Ttrip: 1087.5	mp: 4471.6 dv: 2.3795 Tmp: 4471.6 Tdv: 2.3795
E-M:	pwr: 135.0	m0: 67247.6 E_Vinf: 1.4142	Earth 2034_01_13 M_Vinf: 5.2000	Mars 2037_03_20 s/c: 7349.8	mf: p/l: 57349.8 50000.0	trip: 1162.5 Ttrip: 1162.5	mp: 9897.7 dv: 5.0205 Tmp: 9897.7 Tdv: 5.0205
E-M:	pwr: 135.0	m0: 64016.3 E_Vinf: 1.4142	Earth 2034_01_27 M_Vinf: 5.2000	Mars 2037_05_11 s/c: 7180.8	mf: p/l: 57180.8 50000.0	trip: 1200.0 Ttrip: 1200.0	mp: 6835.5 dv: 3.5607 Tmp: 6835.5 Tdv: 3.5607
E-M:	pwr: 135.0	m0: 61714.1 E_Vinf: 1.4142	Earth 2036_11_30 M_Vinf: 5.2000	Mars 2039_05_19 s/c: 7060.4	mf: p/l: 57060.4 50000.0	trip: 900.0 Ttrip: 900.0	mp: 4653.8 dv: 2.4723 Tmp: 4653.8 Tdv: 2.4723
E-M:	pwr: 135.0	m0: 62680.8 E_Vinf: 1.4142	Earth 2036_11_26 M_Vinf: 5.2000	Mars 2039_07_29 s/c: 7110.9	mf: p/l: 57110.9 50000.0	trip: 975.0 Ttrip: 975.0	mp: 5569.8 dv: 2.9345 Tmp: 5569.8 Tdv: 2.9345
E-M:	pwr: 135.0	m0: 62649.8 E_Vinf: 1.4142	Earth 2036_04_14 M_Vinf: 5.2000	Mars 2039_01_21 s/c: 7109.3	mf: p/l: 57109.3 50000.0	trip: 1012.5 Ttrip: 1012.5	mp: 5540.4 dv: 2.9198 Tmp: 5540.4 Tdv: 2.9198
E-M:	pwr: 135.0	m0: 60376.2 E_Vinf: 1.4142	Earth 2036_03_23 M_Vinf: 5.2000	Mars 2039_03_15 s/c: 6990.4	mf: p/l: 56990.4 50000.0	trip: 1087.5 Ttrip: 1087.5	mp: 3385.8 dv: 1.8199 Tmp: 3385.8 Tdv: 1.8199
E-M:	pwr: 135.0	m0: 65916.3 E_Vinf: 1.4142	Earth 2036_02_17 M_Vinf: 5.2000	Mars 2039_03_18 s/c: 7280.2	mf: p/l: 57280.2 50000.0	trip: 1125.0 Ttrip: 1125.0	mp: 8636.1 dv: 4.4283 Tmp: 8636.1 Tdv: 4.4283
E-M:	pwr: 135.0	m0: 62416.7 E_Vinf: 1.4142	Earth 2036_04_09 M_Vinf: 5.2000	Mars 2039_06_15 s/c: 7097.1	mf: p/l: 57097.1 50000.0	trip: 1162.5 Ttrip: 1162.5	mp: 5319.5 dv: 2.8090 Tmp: 5319.5 Tdv: 2.8090
E-M:	pwr: 135.0	m0: 60435.7 E_Vinf: 1.4142	Earth 2036_03_23 M_Vinf: 5.2000	Mars 2039_07_06 s/c: 6993.5	mf: p/l: 56993.5 50000.0	trip: 1200.0 Ttrip: 1200.0	mp: 3442.2 dv: 1.8492 Tmp: 3442.2 Tdv: 1.8492

E-M:	pwr: 135.0	m0: E_Vinf: 1.4142	62022.8	Earth 2037_01_02 M_Vinf: 5.2000	Mars 2039_06_21 s/c: 7076.5	mf: p/l:	57076.5 50000.0	trip: Ttrip: 900.0	900.0 900.0	mp: Tmp:	4946.3 dv: 4946.3 Tdv:	2.6208 2.6208
E-M:	pwr: 135.0	m0: E_Vinf: 1.4142	62167.0	Earth 2037_01_01 M_Vinf: 5.2000	Mars 2039_07_27 s/c: 7084.1	mf: p/l:	57084.1 50000.0	trip: Ttrip: 937.5	937.5 937.5	mp: Tmp:	5082.9 dv: 5082.9 Tdv:	2.6898 2.6898
E-M:	pwr: 135.0	m0: E_Vinf: 1.4142	63231.9	Earth 2037_01_01 M_Vinf: 5.2000	Mars 2039_09_03 s/c: 7139.8	mf: p/l:	57139.8 50000.0	trip: Ttrip: 975.0	975.0 975.0	mp: Tmp:	6092.2 dv: 6092.2 Tdv:	3.1946 3.1946
E-M:	pwr: 135.0	m0: E_Vinf: 1.4142	61221.2	Earth 2037_11_14 M_Vinf: 5.2000	Mars 2041_01_19 s/c: 7034.6	mf: p/l:	57034.6 50000.0	trip: Ttrip: 1162.5	1162.5 1162.5	mp: Tmp:	4186.6 dv: 4186.6 Tdv:	2.2337 2.2337
E-M:	pwr: 135.0	m0: E_Vinf: 1.4142	62045.6	Earth 2037_09_23 M_Vinf: 5.2000	Mars 2041_01_05 s/c: 7077.7	mf: p/l:	57077.7 50000.0	trip: Ttrip: 1200.0	1200.0 1200.0	mp: Tmp:	4967.9 dv: 4967.9 Tdv:	2.6317 2.6317
E-M:	pwr: 135.0	m0: E_Vinf: 1.4142	60681.3	Earth 2038_11_18 M_Vinf: 5.2000	Mars 2040_10_30 s/c: 7006.3	mf: p/l:	57006.3 50000.0	trip: Ttrip: 712.5	712.5 712.5	mp: Tmp:	3675.0 dv: 3675.0 Tdv:	1.9700 1.9700
E-M:	pwr: 135.0	m0: E_Vinf: 1.4142	61247.3	Earth 2038_12_27 M_Vinf: 5.2000	Mars 2041_03_31 s/c: 7035.9	mf: p/l:	57035.9 50000.0	trip: Ttrip: 825.0	825.0 825.0	mp: Tmp:	4211.3 dv: 4211.3 Tdv:	2.2464 2.2464
E-M:	pwr: 135.0	m0: E_Vinf: 1.4142	60420.9	Earth 2038_12_23 M_Vinf: 5.2000	Mars 2041_05_03 s/c: 6992.7	mf: p/l:	56992.7 50000.0	trip: Ttrip: 862.5	862.5 862.5	mp: Tmp:	3428.2 dv: 3428.2 Tdv:	1.8419 1.8419
E-M:	pwr: 135.0	m0: E_Vinf: 1.4142	61019.5	Earth 2038_12_19 M_Vinf: 5.2000	Mars 2041_06_06 s/c: 7024.0	mf: p/l:	57024.0 50000.0	trip: Ttrip: 900.0	900.0 900.0	mp: Tmp:	3995.5 dv: 3995.5 Tdv:	2.1355 2.1355
E-M:	pwr: 135.0	m0: E_Vinf: 1.4142	62268.5	Earth 2038_05_02 M_Vinf: 5.2000	Mars 2041_01_01 s/c: 7089.4	mf: p/l:	57089.4 50000.0	trip: Ttrip: 975.0	975.0 975.0	mp: Tmp:	5179.1 dv: 5179.1 Tdv:	2.7383 2.7383
E-M:	pwr: 135.0	m0: E_Vinf: 1.4142	60745.7	Earth 2038_04_02 M_Vinf: 5.2000	Mars 2041_01_08 s/c: 7009.7	mf: p/l:	57009.7 50000.0	trip: Ttrip: 1012.5	1012.5 1012.5	mp: Tmp:	3736.0 dv: 3736.0 Tdv:	2.0016 2.0016
E-M:	pwr: 135.0	m0: E_Vinf: 1.4142	63532.7	Earth 2038_05_06 M_Vinf: 5.2000	Mars 2041_04_27 s/c: 7155.5	mf: p/l:	57155.5 50000.0	trip: Ttrip: 1087.5	1087.5 1087.5	mp: Tmp:	6377.2 dv: 6377.2 Tdv:	3.3356 3.3356
E-M:	pwr: 135.0	m0: E_Vinf: 1.4142	61356.4	Earth 2038_04_26 M_Vinf: 5.2000	Mars 2041_05_25 s/c: 7041.7	mf: p/l:	57041.7 50000.0	trip: Ttrip: 1125.0	1125.0 1125.0	mp: Tmp:	4314.7 dv: 4314.7 Tdv:	2.2993 2.2993
E-M:	pwr: 135.0	m0: E_Vinf: 1.4142	59901.7	Earth 2038_04_02 M_Vinf: 5.2000	Mars 2041_06_07 s/c: 6965.6	mf: p/l:	56965.6 50000.0	trip: Ttrip: 1162.5	1162.5 1162.5	mp: Tmp:	2936.1 dv: 2936.1 Tdv:	1.5848 1.5848
E-M:	pwr: 135.0	m0: E_Vinf: 1.4142	59459.0	Earth 2038_03_16 M_Vinf: 5.2000	Mars 2041_06_28 s/c: 6942.4	mf: p/l:	56942.4 50000.0	trip: Ttrip: 1200.0	1200.0 1200.0	mp: Tmp:	2516.6 dv: 2516.6 Tdv:	1.3637 1.3637
E-M:	pwr: 135.0	m0: E_Vinf: 1.4142	61258.6	Earth 2039_01_02 M_Vinf: 5.2000	Mars 2041_04_06 s/c: 7036.5	mf: p/l:	57036.5 50000.0	trip: Ttrip: 825.0	825.0 825.0	mp: Tmp:	4222.1 dv: 4222.1 Tdv:	2.2519 2.2519
E-M:	pwr: 135.0	m0: E_Vinf: 1.4142	60440.3	Earth 2039_01_01 M_Vinf: 5.2000	Mars 2041_05_12 s/c: 6993.7	mf: p/l:	56993.7 50000.0	trip: Ttrip: 862.5	862.5 862.5	mp: Tmp:	3446.6 dv: 3446.6 Tdv:	1.8515 1.8515
E-M:	pwr: 135.0	m0: E_Vinf: 1.4142	61051.4	Earth 2039_01_01 M_Vinf: 5.2000	Mars 2041_06_19 s/c: 7025.7	mf: p/l:	57025.7 50000.0	trip: Ttrip: 900.0	900.0 900.0	mp: Tmp:	4025.7 dv: 4025.7 Tdv:	2.1510 2.1510
E-M:	pwr: 135.0	m0: E_Vinf: 1.4142	62815.5	Earth 2039_01_01 M_Vinf: 5.2000	Mars 2041_07_26 s/c: 7118.0	mf: p/l:	57118.0 50000.0	trip: Ttrip: 937.5	937.5 937.5	mp: Tmp:	5697.6 dv: 5697.6 Tdv:	2.9983 2.9983
E-M:	pwr: 135.0	m0: E_Vinf: 1.4142	61897.4	Earth 2039_10_01 M_Vinf: 5.2000	Mars 2042_12_06 s/c: 7070.0	mf: p/l:	57070.0 50000.0	trip: Ttrip: 1162.5	1162.5 1162.5	mp: Tmp:	4827.4 dv: 4827.4 Tdv:	2.5605 2.5605

E-M:	pwr: 135.0	m0: 60885.8 E_Vinf: 1.4142	Earth 2040_11_25 M_Vinf: 5.2000	Mars 2042_11_07 S/c: 7017.0	mf: p/l:	57017.0 50000.0	trip: 712.5 Ttrip: 712.5	mp: Tmp:	3868.8 dv: 3868.8 Tdv:	2.0702 2.0702
E-M:	pwr: 135.0	m0: 63353.6 E_Vinf: 1.4142	Earth 2040_10_01 M_Vinf: 5.2000	Mars 2042_10_21 S/c: 7146.1	mf: p/l:	57146.1 50000.0	trip: 750.0 Ttrip: 750.0	mp: Tmp:	6207.5 dv: 6207.5 Tdv:	3.2517 3.2517
E-M:	pwr: 135.0	m0: 60185.5 E_Vinf: 1.4142	Earth 2040_12_30 M_Vinf: 5.2000	Mars 2043_04_04 S/c: 6980.4	mf: p/l:	56980.4 50000.0	trip: 825.0 Ttrip: 825.0	mp: Tmp:	3205.1 dv: 3205.1 Tdv:	1.7257 1.7257
E-M:	pwr: 135.0	m0: 61093.2 E_Vinf: 1.4142	Earth 2040_12_30 M_Vinf: 5.2000	Mars 2043_05_11 S/c: 7027.9	mf: p/l:	57027.9 50000.0	trip: 862.5 Ttrip: 862.5	mp: Tmp:	4065.4 dv: 4065.4 Tdv:	2.1714 2.1714
E-M:	pwr: 135.0	m0: 64796.4 E_Vinf: 1.4142	Earth 2040_06_03 M_Vinf: 5.2000	Mars 2042_11_20 S/c: 7221.6	mf: p/l:	57221.6 50000.0	trip: 900.0 Ttrip: 900.0	mp: Tmp:	7574.8 dv: 7574.8 Tdv:	3.9202 3.9202
E-M:	pwr: 135.0	m0: 62147.7 E_Vinf: 1.4142	Earth 2040_05_10 M_Vinf: 5.2000	Mars 2042_12_03 S/c: 7083.1	mf: p/l:	57083.1 50000.0	trip: 937.5 Ttrip: 937.5	mp: Tmp:	5064.6 dv: 5064.6 Tdv:	2.6806 2.6806
E-M:	pwr: 135.0	m0: 60841.1 E_Vinf: 1.4142	Earth 2040_04_18 M_Vinf: 5.2000	Mars 2042_12_19 S/c: 7014.7	mf: p/l:	57014.7 50000.0	trip: 975.0 Ttrip: 975.0	mp: Tmp:	3826.4 dv: 3826.4 Tdv:	2.0483 2.0483
E-M:	pwr: 135.0	m0: 64486.2 E_Vinf: 1.4142	Earth 2040_06_16 M_Vinf: 5.2000	Mars 2043_03_25 S/c: 7205.4	mf: p/l:	57205.4 50000.0	trip: 1012.5 Ttrip: 1012.5	mp: Tmp:	7280.8 dv: 7280.8 Tdv:	3.7778 3.7778
E-M:	pwr: 135.0	m0: 62476.2 E_Vinf: 1.4142	Earth 2040_05_20 M_Vinf: 5.2000	Mars 2043_04_05 S/c: 7100.2	mf: p/l:	57100.2 50000.0	trip: 1050.0 Ttrip: 1050.0	mp: Tmp:	5375.9 dv: 5375.9 Tdv:	2.8373 2.8373
E-M:	pwr: 135.0	m0: 60979.7 E_Vinf: 1.4142	Earth 2040_05_04 M_Vinf: 5.2000	Mars 2043_04_26 S/c: 7022.0	mf: p/l:	57022.0 50000.0	trip: 1087.5 Ttrip: 1087.5	mp: Tmp:	3957.8 dv: 3957.8 Tdv:	2.1161 2.1161
E-M:	pwr: 135.0	m0: 60144.7 E_Vinf: 1.4142	Earth 2040_04_07 M_Vinf: 5.2000	Mars 2043_05_07 S/c: 6978.3	mf: p/l:	56978.3 50000.0	trip: 1125.0 Ttrip: 1125.0	mp: Tmp:	3166.4 dv: 3166.4 Tdv:	1.7054 1.7054
E-M:	pwr: 135.0	m0: 59950.7 E_Vinf: 1.4142	Earth 2040_03_07 M_Vinf: 5.2000	Mars 2043_05_13 S/c: 6968.1	mf: p/l:	56968.1 50000.0	trip: 1162.5 Ttrip: 1162.5	mp: Tmp:	2982.6 dv: 2982.6 Tdv:	1.6092 1.6092
E-M:	pwr: 135.0	m0: 60580.8 E_Vinf: 1.4142	Earth 2040_02_11 M_Vinf: 5.2000	Mars 2043_05_26 S/c: 7001.1	mf: p/l:	57001.1 50000.0	trip: 1200.0 Ttrip: 1200.0	mp: Tmp:	3579.8 dv: 3579.8 Tdv:	1.9207 1.9207
E-M:	pwr: 135.0	m0: 61811.8 E_Vinf: 1.4142	Earth 2041_01_31 M_Vinf: 5.2000	Mars 2043_02_20 S/c: 7065.5	mf: p/l:	57065.5 50000.0	trip: 750.0 Ttrip: 750.0	mp: Tmp:	4746.3 dv: 4746.3 Tdv:	2.5194 2.5194
E-M:	pwr: 135.0	m0: 59939.2 E_Vinf: 1.4142	Earth 2041_02_05 M_Vinf: 5.2000	Mars 2043_04_03 S/c: 6967.5	mf: p/l:	56967.5 50000.0	trip: 787.5 Ttrip: 787.5	mp: Tmp:	2971.6 dv: 2971.6 Tdv:	1.6034 1.6034
E-M:	pwr: 135.0	m0: 59954.5 E_Vinf: 1.4142	Earth 2041_01_29 M_Vinf: 5.2000	Mars 2043_05_04 S/c: 6968.3	mf: p/l:	56968.3 50000.0	trip: 825.0 Ttrip: 825.0	mp: Tmp:	2986.2 dv: 2986.2 Tdv:	1.6111 1.6111
E-M:	pwr: 135.0	m0: 61077.7 E_Vinf: 1.4142	Earth 2041_01_08 M_Vinf: 5.2000	Mars 2043_05_20 S/c: 7027.1	mf: p/l:	57027.1 50000.0	trip: 862.5 Ttrip: 862.5	mp: Tmp:	4050.6 dv: 4050.6 Tdv:	2.1638 2.1638
E-M:	pwr: 135.0	m0: 63509.0 E_Vinf: 1.4142	Earth 2041_01_01 M_Vinf: 5.2000	Mars 2043_06_20 S/c: 7154.3	mf: p/l:	57154.3 50000.0	trip: 900.0 Ttrip: 900.0	mp: Tmp:	6354.7 dv: 6354.7 Tdv:	3.3245 3.3245
E-M:	pwr: 135.0	m0: 61770.8 E_Vinf: 1.4142	Earth 2041_11_27 M_Vinf: 5.2000	Mars 2045_03_11 S/c: 7063.3	mf: p/l:	57063.3 50000.0	trip: 1200.0 Ttrip: 1200.0	mp: Tmp:	4707.4 dv: 4707.4 Tdv:	2.4996 2.4996
E-M:	pwr: 135.0	m0: 64083.8 E_Vinf: 1.4142	Earth 2042_06_13 M_Vinf: 5.2000	Mars 2044_10_22 S/c: 7184.3	mf: p/l:	57184.3 50000.0	trip: 862.5 Ttrip: 862.5	mp: Tmp:	6899.5 dv: 6899.5 Tdv:	3.5921 3.5921

E-M:	pwr: 135.0	m0: 62410.3 E_Vinf: 1.4142	Earth 2042_05_30 M_Vinf: 5.2000	Mars 2044_11_15 s/c: 7096.8	mf: p/l: 57096.8 50000.0	trip: 900.0 Ttrip: 900.0	mp: 5313.5 Tmp: 5313.5 Tdv: 2.8059
E-M:	pwr: 135.0	m0: 61365.3 E_Vinf: 1.4142	Earth 2042_04_29 M_Vinf: 5.2000	Mars 2044_11_21 s/c: 7042.1	mf: p/l: 57042.1 50000.0	trip: 937.5 Ttrip: 937.5	mp: 4323.2 Tmp: 4323.2 Tdv: 2.3037
E-M:	pwr: 135.0	m0: 60810.6 E_Vinf: 1.4142	Earth 2042_04_07 M_Vinf: 5.2000	Mars 2044_12_07 s/c: 7013.1	mf: p/l: 57013.1 50000.0	trip: 975.0 Ttrip: 975.0	mp: 3797.5 Tmp: 3797.5 Tdv: 2.0334
E-M:	pwr: 135.0	m0: 60856.9 E_Vinf: 1.4142	Earth 2042_03_06 M_Vinf: 5.2000	Mars 2044_12_12 s/c: 7015.5	mf: p/l: 57015.5 50000.0	trip: 1012.5 Ttrip: 1012.5	mp: 3841.4 Tmp: 3841.4 Tdv: 2.0361
E-M:	pwr: 135.0	m0: 61390.5 E_Vinf: 1.4142	Earth 2042_05_02 M_Vinf: 5.2000	Mars 2045_03_17 s/c: 7043.4	mf: p/l: 57043.4 50000.0	trip: 1050.0 Ttrip: 1050.0	mp: 4347.0 Tmp: 4347.0 Tdv: 2.3159
E-M:	pwr: 135.0	m0: 60881.0 E_Vinf: 1.4142	Earth 2042_04_03 M_Vinf: 5.2000	Mars 2045_03_25 s/c: 7016.8	mf: p/l: 57016.8 50000.0	trip: 1087.5 Ttrip: 1087.5	mp: 3864.2 Tmp: 3864.2 Tdv: 2.0678
E-M:	pwr: 135.0	m0: 60925.4 E_Vinf: 1.4142	Earth 2042_03_03 M_Vinf: 5.2000	Mars 2045_04_01 s/c: 7019.1	mf: p/l: 57019.1 50000.0	trip: 1125.0 Ttrip: 1125.0	mp: 3906.3 Tmp: 3906.3 Tdv: 2.0896
E-M:	pwr: 135.0	m0: 61480.4 E_Vinf: 1.4142	Earth 2042_01_16 M_Vinf: 5.2000	Mars 2045_03_23 s/c: 7048.1	mf: p/l: 57048.1 50000.0	trip: 1162.5 Ttrip: 1162.5	mp: 4432.3 Tmp: 4432.3 Tdv: 2.3595
E-M:	pwr: 135.0	m0: 61948.2 E_Vinf: 1.4142	Earth 2042_01_01 M_Vinf: 5.2000	Mars 2045_04_15 s/c: 7072.6	mf: p/l: 57072.6 50000.0	trip: 1200.0 Ttrip: 1200.0	mp: 4875.6 Tmp: 4875.6 Tdv: 2.5849
E-M:	pwr: 135.0	m0: 60791.2 E_Vinf: 1.4142	Earth 2043_03_16 M_Vinf: 5.2000	Mars 2045_02_25 s/c: 7012.1	mf: p/l: 57012.1 50000.0	trip: 712.5 Ttrip: 712.5	mp: 3779.1 Tmp: 3779.1 Tdv: 2.0239
E-M:	pwr: 135.0	m0: 59732.6 E_Vinf: 1.4142	Earth 2043_03_14 M_Vinf: 5.2000	Mars 2045_04_02 s/c: 6956.7	mf: p/l: 56956.7 50000.0	trip: 750.0 Ttrip: 750.0	mp: 2775.9 Tmp: 2775.9 Tdv: 1.5006
E-M:	pwr: 135.0	m0: 60442.2 E_Vinf: 1.4142	Earth 2043_02_23 M_Vinf: 5.2000	Mars 2045_04_20 s/c: 6993.8	mf: p/l: 56993.8 50000.0	trip: 787.5 Ttrip: 787.5	mp: 3448.3 Tmp: 3448.3 Tdv: 1.8524
E-M:	pwr: 135.0	m0: 61823.5 E_Vinf: 1.4142	Earth 2043_01_01 M_Vinf: 5.2000	Mars 2045_04_05 s/c: 7066.1	mf: p/l: 57066.1 50000.0	trip: 825.0 Ttrip: 825.0	mp: 4757.4 Tmp: 4757.4 Tdv: 2.5250
E-M:	pwr: 135.0	m0: 62495.1 E_Vinf: 1.4142	Earth 2043_12_29 M_Vinf: 5.2000	Mars 2047_01_27 s/c: 7101.2	mf: p/l: 57101.2 50000.0	trip: 1125.0 Ttrip: 1125.0	mp: 5393.8 Tmp: 5393.8 Tdv: 2.8463
E-M:	pwr: 135.0	m0: 62329.5 E_Vinf: 1.4142	Earth 2043_10_18 M_Vinf: 5.2000	Mars 2047_01_30 s/c: 7092.6	mf: p/l: 57092.6 50000.0	trip: 1200.0 Ttrip: 1200.0	mp: 5237.0 Tmp: 5237.0 Tdv: 2.7674
E-M:	pwr: 135.0	m0: 63302.3 E_Vinf: 1.4142	Earth 2044_11_26 M_Vinf: 5.2000	Mars 2047_01_22 s/c: 7143.5	mf: p/l: 57143.5 50000.0	trip: 787.5 Ttrip: 787.5	mp: 6158.8 Tmp: 6158.8 Tdv: 3.2277
E-M:	pwr: 135.0	m0: 63983.0 E_Vinf: 1.4142	Earth 2044_06_20 M_Vinf: 5.2000	Mars 2046_09_23 s/c: 7179.1	mf: p/l: 57179.1 50000.0	trip: 825.0 Ttrip: 825.0	mp: 6803.9 Tmp: 6803.9 Tdv: 3.5453
E-M:	pwr: 135.0	m0: 63095.1 E_Vinf: 1.4142	Earth 2044_05_27 M_Vinf: 5.2000	Mars 2046_10_06 s/c: 7132.6	mf: p/l: 57132.6 50000.0	trip: 862.5 Ttrip: 862.5	mp: 5962.4 Tmp: 5962.4 Tdv: 3.1303
E-M:	pwr: 135.0	m0: 62363.1 E_Vinf: 1.4142	Earth 2044_05_08 M_Vinf: 5.2000	Mars 2046_10_25 s/c: 7094.3	mf: p/l: 57094.3 50000.0	trip: 900.0 Ttrip: 900.0	mp: 5268.8 Tmp: 5268.8 Tdv: 2.7834
E-M:	pwr: 135.0	m0: 61934.9 E_Vinf: 1.4142	Earth 2044_04_15 M_Vinf: 5.2000	Mars 2046_11_08 s/c: 7071.9	mf: p/l: 57071.9 50000.0	trip: 937.5 Ttrip: 937.5	mp: 4862.9 Tmp: 4862.9 Tdv: 2.5785

E-M:	pwr: 135.0	m0: E_Vinf: 62031.6 1.4142	Earth 2044_03_15 M_Vinf: 5.2000	Mars 2046_11_15 s/c: 7077.0	mf: p/l: 57077.0 50000.0	trip: Ttrip: 975.0 975.0	mp: Tmp: 4954.6 4954.6	dv: Tdv: 2.6249 2.6249
E-M:	pwr: 135.0	m0: E_Vinf: 62360.0 1.4142	Earth 2044_04_27 M_Vinf: 5.2000	Mars 2047_02_03 s/c: 7094.2	mf: p/l: 57094.2 50000.0	trip: Ttrip: 1012.5 1012.5	mp: Tmp: 5265.9 5265.9	dv: Tdv: 2.7820 2.7820
E-M:	pwr: 135.0	m0: E_Vinf: 62174.2 1.4142	Earth 2044_03_22 M_Vinf: 5.2000	Mars 2047_02_05 s/c: 7084.4	mf: p/l: 57084.4 50000.0	trip: Ttrip: 1050.0 1050.0	mp: Tmp: 5089.7 5089.7	dv: Tdv: 2.6932 2.6932
E-M:	pwr: 135.0	m0: E_Vinf: 62281.0 1.4142	Earth 2044_02_13 M_Vinf: 5.2000	Mars 2047_02_04 s/c: 7090.0	mf: p/l: 57090.0 50000.0	trip: Ttrip: 1087.5 1087.5	mp: Tmp: 5190.9 5190.9	dv: Tdv: 2.7443 2.7443
E-M:	pwr: 135.0	m0: E_Vinf: 62499.7 1.4142	Earth 2044_01_02 M_Vinf: 5.2000	Mars 2047_01_31 s/c: 7101.5	mf: p/l: 57101.5 50000.0	trip: Ttrip: 1125.0 1125.0	mp: Tmp: 5398.3 5398.3	dv: Tdv: 2.8485 2.8485
E-M:	pwr: 135.0	m0: E_Vinf: 62717.1 1.4142	Earth 2044_01_01 M_Vinf: 5.2000	Mars 2047_03_08 s/c: 7112.8	mf: p/l: 57112.8 50000.0	trip: Ttrip: 1162.5 1162.5	mp: Tmp: 5604.3 5604.3	dv: Tdv: 2.9517 2.9517
E-M:	pwr: 135.0	m0: E_Vinf: 62760.6 1.4142	Earth 2045_04_11 M_Vinf: 5.2000	Mars 2047_01_08 s/c: 7115.1	mf: p/l: 57115.1 50000.0	trip: Ttrip: 637.5 637.5	mp: Tmp: 5645.5 5645.5	dv: Tdv: 2.9723 2.9723
E-M:	pwr: 135.0	m0: E_Vinf: 61343.2 1.4142	Earth 2045_04_05 M_Vinf: 5.2000	Mars 2047_02_09 s/c: 7041.0	mf: p/l: 57041.0 50000.0	trip: Ttrip: 675.0 675.0	mp: Tmp: 4302.2 4302.2	dv: Tdv: 2.2929 2.2929
E-M:	pwr: 135.0	m0: E_Vinf: 61375.6 1.4142	Earth 2045_03_17 M_Vinf: 5.2000	Mars 2047_02_27 s/c: 7042.7	mf: p/l: 57042.7 50000.0	trip: Ttrip: 712.5 712.5	mp: Tmp: 4332.9 4332.9	dv: Tdv: 2.3087 2.3087
E-M:	pwr: 135.0	m0: E_Vinf: 62331.1 1.4142	Earth 2045_02_02 M_Vinf: 5.2000	Mars 2047_02_22 s/c: 7092.7	mf: p/l: 57092.6 50000.0	trip: Ttrip: 750.0 750.0	mp: Tmp: 5238.5 5238.5	dv: Tdv: 2.7682 2.7682
E-M:	pwr: 135.0	m0: E_Vinf: 63481.3 1.4142	Earth 2045_01_01 M_Vinf: 5.2000	Mars 2047_02_27 s/c: 7152.8	mf: p/l: 57152.8 50000.0	trip: Ttrip: 787.5 787.5	mp: Tmp: 6328.5 6328.5	dv: Tdv: 3.3116 3.3116
E-M:	pwr: 135.0	m0: E_Vinf: 64259.1 1.4142	Earth 2046_06_29 M_Vinf: 5.2000	Mars 2048_08_24 s/c: 7193.5	mf: p/l: 57193.5 50000.0	trip: Ttrip: 787.5 787.5	mp: Tmp: 7065.6 7065.6	dv: Tdv: 3.6731 3.6731
E-M:	pwr: 135.0	m0: E_Vinf: 63825.2 1.4142	Earth 2046_08_10 M_Vinf: 5.2000	Mars 2048_11_12 s/c: 7170.8	mf: p/l: 57170.8 50000.0	trip: Ttrip: 825.0 825.0	mp: Tmp: 6654.4 6654.4	dv: Tdv: 3.4720 3.4720
E-M:	pwr: 135.0	m0: E_Vinf: 63753.3 1.4142	Earth 2046_05_19 M_Vinf: 5.2000	Mars 2048_09_27 s/c: 7167.0	mf: p/l: 57167.1 50000.0	trip: Ttrip: 862.5 862.5	mp: Tmp: 6586.3 6586.3	dv: Tdv: 3.4386 3.4386
E-M:	pwr: 135.0	m0: E_Vinf: 63682.7 1.4142	Earth 2046_04_27 M_Vinf: 5.2000	Mars 2048_10_13 s/c: 7163.4	mf: p/l: 57163.4 50000.0	trip: Ttrip: 900.0 900.0	mp: Tmp: 6519.3 6519.3	dv: Tdv: 3.4056 3.4056
E-M:	pwr: 135.0	m0: E_Vinf: 63915.1 1.4142	Earth 2046_03_18 M_Vinf: 5.2000	Mars 2048_10_10 s/c: 7175.5	mf: p/l: 57175.5 50000.0	trip: Ttrip: 937.5 937.5	mp: Tmp: 6739.6 6739.6	dv: Tdv: 3.5138 3.5138
E-M:	pwr: 135.0	m0: E_Vinf: 63945.7 1.4142	Earth 2046_02_03 M_Vinf: 5.2000	Mars 2048_10_05 s/c: 7177.1	mf: p/l: 57177.1 50000.0	trip: Ttrip: 975.0 975.0	mp: Tmp: 6768.6 6768.6	dv: Tdv: 3.5280 3.5280
E-M:	pwr: 135.0	m0: E_Vinf: 63925.1 1.4142	Earth 2046_03_03 M_Vinf: 5.2000	Mars 2048_12_09 s/c: 7176.0	mf: p/l: 57176.0 50000.0	trip: Ttrip: 1012.5 1012.5	mp: Tmp: 6749.1 6749.1	dv: Tdv: 3.5184 3.5184
E-M:	pwr: 135.0	m0: E_Vinf: 66269.5 1.4142	Earth 2046_02_18 M_Vinf: 5.2000	Mars 2049_01_03 s/c: 7298.7	mf: p/l: 57298.7 50000.0	trip: Ttrip: 1050.0 1050.0	mp: Tmp: 8970.8 8970.8	dv: Tdv: 4.5866 4.5866
E-M:	pwr: 135.0	m0: E_Vinf: 63635.1 1.4142	Earth 2046_01_01 M_Vinf: 5.2000	Mars 2048_12_23 s/c: 7160.9	mf: p/l: 57160.9 50000.0	trip: Ttrip: 1087.5 1087.5	mp: Tmp: 6474.3 6474.3	dv: Tdv: 3.3834 3.3834

E-M:	pwr: 135.0	m0: 64542.3 E_Vinf: 1.4142	Earth 2048_08_23 M_Vinf: 5.2000	Mars 2050_09_12 s/c: 7208.3	mf: p/l:	57208.3 50000.0	trip: Ttrip:	750.0 750.0	mp: Tmp:	7334.0 7334.0	dv: Tdv:	3.8036 3.8036
E-M:	pwr: 135.0	m0: 64305.3 E_Vinf: 1.4142	Earth 2048_08_17 M_Vinf: 5.2000	Mars 2050_10_13 s/c: 7195.9	mf: p/l:	57195.9 50000.0	trip: Ttrip:	787.5 787.5	mp: Tmp:	7109.3 7109.3	dv: Tdv:	3.6944 3.6944
E-M:	pwr: 135.0	m0: 65169.4 E_Vinf: 1.4142	Earth 2048_07_17 M_Vinf: 5.2000	Mars 2050_10_20 s/c: 7241.1	mf: p/l:	57241.1 50000.0	trip: Ttrip:	825.0 825.0	mp: Tmp:	7928.3 7928.3	dv: Tdv:	4.0905 4.0905